ServiceLab 7.0

32-bit version for
Windows 98
Windows NT V4
Windows 2000
Windows XP Pro

Book 1:
User Guide

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Year 2000 Compliance Statement

ServiceLab 7.0 is Year-2000-compliant. It conforms to the British Standards Institution BSI DISC PD-2000-1 'A Definition of Year 2000 Conformity Requirements‘ document. Specifically, ***ServiceLab*** will:

- Work correctly for the following the transition from December 31, 1999 to January 1, 2000
- Recognize that 2000 is a leap year;
- Work correctly for all dates in the range January 1, 1980 through December 31, 2037, but not before, and not after
- Read and store dates correctly using its private (.DDF) data format, and store appropriately for other date formats

Risky Applications

Warning:

(1) ***ServiceLab*** is not designed with components and testing for a level of reliability suitable for use in or in connection with surgical implants or as critical components in any life support systems whose failure to perform can reasonably be expected to cause significant injury to a human.

(2) In any application, including the above, reliability of operation of the software products can be impaired by adverse factors, including but not limited to fluctuations in electrical power supply, computer hardware malfunctions, computer operating system software fitness, fitness of compilers and development software used to develop an application, installation errors, software and hardware compatibility problems, malfunctions or failures of electronic monitoring or control devices, transient failures of electronic systems (hardware and/or software), unanticipated uses or misuses, or errors on the part of the user or applications designer (adverse factors such as these are hereafter collectively termed "system failures").

Any application where a system failure would create a risk of harm to property or persons (including the risk of bodily injury and death) should not be reliant solely upon one form of electronic system due to the risk of system failure.

To avoid damage, injury, or death, the user or application designer must take reasonably prudent steps to protect against system failures, including but not limited to back-up or shut down mechanisms.

Because each end-user system is customized and differs from the testing platforms of ***ServiceLab Ltd.*** and because a user or application designer may use ***ServiceLab Ltd.*** products in combination with other products in a manner not evaluated or contemplated by ***ServiceLab Ltd.***, the user or application designer is ultimately responsible for verifying and validating the suitability of ***ServiceLab Ltd.*** products whenever ***ServiceLab Ltd.*** products are incorporated in a system or application, including, without limitation, the appropriate design, process and safety level of such system or application.

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Chapter 1: Introduction

1. Welcome to *ServiceLab*!

You have acquired an easy to use software product that provides an enormous range of functions and options for your data acquisition tasks. Install this electronic laboratory on your computer and start experimenting; you will quickly discover many of ***ServiceLab***'s powerful features.

Use ***ServiceLab's*** Online Help system to display information about the operation that you are about to carry out on the screen. It may be unnecessary for you to thoroughly study this printed manual.

If you are new to ***ServiceLab***, we recommend that you read through the Step-by-Step Instructions in the online Help system, or read this introductory chapter plus Chapters 2 and 3. You will then know enough to start off with ***ServiceLab*** on your own.

If you have upgraded from a previous version of ***ServiceLab***, please review Chapter 1 – Section 6 for information about new and changed features.

Later, this User Guide can help you find your way through ***ServiceLab*** even when you are not at your computer. It can serve as a reference book and it will provide background information that might seem out of place in the immediacy of the online Help system.

2. About your *ServiceLab* Documentation

2.1. What's Included

The ***ServiceLab*** documentation consists of the following:

- The context-sensitive online Help system provides quick on-screen reference to procedures and commands you may need while working with ***ServiceLab***. In addition, hardware help is provided to describe the installation, setup, and use of your specific data acquisition device.
- This User Guide contains a comprehensive description of all of ***ServiceLab***'s functions and their uses. It serves as a reference book, providing background information.
- The book, Volume 2 of the User Guide, the Module Reference Guide, with complete descriptions of each Module Group and Module.
- The Hardware Information Manual provides a description of the interface between the data acquisition hardware and ***ServiceLab***. This manual may not be provided with all packages. If not, review the README.WRI file and any hardware specific online help that is installed.

- README.WRI, an information file that is copied to your hard disk when you set up ***ServiceLab***, provides information that was updated after this User Guide was printed. You can easily read (or print) this file using Windows Write.

⇨ *We strongly recommend that you read the **README.WRI** file before you start working with the software.*

2.2. Contents

The ***ServiceLab*** User Guide is divided into the following parts:

Chapter 1: A general introduction to the software. It explains the basic concepts and provides setup information. It includes an overview of the new features and changes in this version.

Chapter 2: Operating fundamentals. This chapter explains the skills you need to work with ***ServiceLab***, how you start the program, and how you can use the online Help system. You can then follow a tutorial.

Chapter 3: A systematic survey of the elements you will use when working with ***ServiceLab***.

Chapter 4: A description of all of ***ServiceLab*** menu commands and functions (except those from the Module menu). The chapter's structure corresponds to the ***ServiceLab*** menu system.

Chapter 5: Background information about file formats and data exchange between Windows applications.

Chapter 6: Additional hints and background information structured along particular tasks or problems that may arise during your work with ***ServiceLab***.

Appendices: Lists of program specifications and error messages, a glossary, the License Agreement and a comprehensive Index of Topics covering Chapters 1 to 7.

⇨ *Please do not forget to send us your Registration Card.*

The ***ServiceLab*** Module Reference Guide includes detailed descriptions for each module.

The Hardware Information Manual contains a description of your device with information concerning setup and operation with ***ServiceLab***.

2.3. Typographic Conventions

We have used visual cues and standard text formats in this User Guide to help you locate and interpret information easily.

Text Formats

File names and directory names are printed in ALL CAPITALS.

All references to menus, menu commands and to the options available in dialog boxes are printed in this sans serif typeface.

All references to keyboard keys and command entries are printed in `this text format`. These are usually commands that you must type at the DOS Prompt or in ***ServiceLab*** or Windows text boxes exactly as you find them printed in this manual. It does not matter whether you type upper or lowercase letters.

Keyboard Formats

Key combinations and key sequences:

`KEY1+KEY2` means to press and hold down the first key while you press the second.

`KEY1`**,** `KEY2` means to press and release the keys one at a time.

Symbols

We have used the following symbols throughout this User's Guide to identify important information to guide you to information on a related topic:

Serious Warning! *Neglecting the hints indicated by this symbol may result in severe program errors or even damage to your hardware.*

Warning*. Neglecting the hints indicated by this symbol may result in* ***ServiceLab*** *not operating properly; data may be misinterpreted or not calculated correctly. This symbol will remind you to check that parameters are set correctly, or to check settings that must match.*

When you have read a passage about a subject, this symbol may indicate that explanations on a related subject can be obtained elsewhere in this User Guide, or that similar commands, options, etc. might be of interest in the current context.

3. What is *ServiceLab*?

Data Acquisition and Analysis under Windows

ServiceLab is a data acquisition, process control, and analysis system which takes full advantage of the features and the graphical interface provided by Microsoft® Windows™.

The most important design requirements for ***ServiceLab*** were the integration of the important measuring and control devices on the market, a truly intuitive operating environment which offers extensive help functions, a maximum signal processing speed, and the most effective graphical display of results.

Intuitive Operation

Using ***ServiceLab***, a measuring, process control, or simulation task can be set up directly on your screen by selecting and connecting modular elements that can then be freely arranged. Even highly specialized tasks can be solved immediately on the screen, interactively and without difficulty. It is no longer necessary to find your way through lengthy and rigid menu structures.

Large Variety of Measuring, Control, and Analysis Functions

Among the module functions provided are A/D and D/A converters, Pre/Post and Start/Stop Triggers, digital I/O, mathematical functions from fundamental arithmetic to integral and differential calculus, statistics, digital filters of several types, frequency analysis including various evaluation windows, signal generators for simulation purposes, scopes for the graphic display of results, logical connectors like AND, OR, NOR, etc., counters, a chart recorder, file I/O, timer, digital display, bar graph, analog meter and more.

Measuring Technology under Windows

With ***ServiceLab*** it is now possible to achieve high signal input/output rates using the full power of the PC. Special buffers with large, selectable, memory address ranges enable continuous data transfer from the data acquisition device through to the software. ***ServiceLab*** uses extremely sophisticated drivers to obtain real-time logging at a rate of up to 800 kHz and real-time on-screen signal display at a rate of up to 70 kHz (depending on the type of data acquisition device and graphics board installed).

Flexible Worksheet Setup

In spite of its complexity and high performance, ***ServiceLab*** can be used easily. The worksheet displayed on screen can be edited at any time. New modules can be inserted; others can be moved to a different position or deleted altogether. Dialog boxes prompt for all the necessary parameters to be set for an experiment.

Use the Black Box module to take combinations of worksheet elements repeatedly required in your experiments, and integrate them into a Black Box module, which you can then insert into worksheets as ready-to-use units. This will save you time and simplify your worksheets.

Integrated Autorouter Utility

While you are connecting the module inputs and outputs using the mouse, these connections are displayed as direct lines, but as soon as the mouse button is released the integrated autorouter optimizes all these connections. This prevents data channel lines being drawn through or behind existing module symbols or too close to other lines.

In the same way, the integrated autorouter rearranges the display whenever a module symbol has been moved. It thus creates a readable worksheet diagram ready for documentation purposes.

Ample Resources

The maximum worksheet size is 2000 by 2000 pixels, and a worksheet can contain up to 256 modules. For most modules up to 16 inputs and/or outputs can be configured.

The virtual working area at the user's disposal is much larger than what can actually be presented in the active window on screen. When dealing with more extensive applications, where the complete arrangement of module symbols will not fit on the screen, you can scroll through the screen window vertically and horizontally. In addition, an overview command, several tagging functions, and the ability to hide the worksheet diagram help you to keep track of the setup and experiment.

Function Bar and Module Bar

Icon bars that provide commands and functions that might be repeatedly required when experiments are set up and carried out enhance *ServiceLab*'s user-friendliness considerably.

You can define the Module Bar on the left of the screen to reflect your preferences. You can assign module functions that you need most often in your individual tasks to the buttons on the Module Bar. Once configured, these settings can be saved and reused for other worksheets or experiments. Various configurations adapted to the individual requirements of different tasks are easily reused.

Display of Results

Readings can be displayed graphically or numerically using specially assigned modules. This can be done effectively by making use of scope modules. Each one provides a resizable window in which data from several channels can be displayed; a system of suitable coordinates (linear, logarithmic, polar, waterfall), and different color codes (for multiple signals) can be selected.

Scaleable analog instruments, bar graphs and LED indicators are especially helpful when it comes to process control and testing. As these elements can be freely placed and combined, all the instruments necessary for any process can be integrated completely.

Storing the Setup

The complete experiment setup, including all the currently selected parameters, window positions, and additional information can be saved to a file and opened again later. Multiple ready-to-use standard setups for different tasks can be developed. The corresponding data acquisition process itself can even be started automatically at a specified time, when your computer restarts or when Windows starts.

Storing Data and Data Exchange

The acquired data and process results can also be saved to files so that they can be retrieved for further processing at a later time. They can be analyzed in detail, or used for simulation and training.

Use DDE (Dynamic Data Exchange) to transfer data directly to other Windows applications supporting the DDE protocol. For example: Excel and applications with DDE capabilities may be used to start ***ServiceLab*** and control it while running an experiment.

Process Control Applications

External systems can be controlled by employing appropriate modules for digital I/O or D/A conversion. ***ServiceLab*** provides a wide range of powerful modules for binary operations (AND / OR / NOT etc.), counters, and PID control functions.

Precise time-related process control operations depending on complex signals can be realized with ***ServiceLab***. Output frequencies, slopes, duration, dependencies on certain input source conditions, etc., can be determined for several channels by the user.

Simulation – for Testing and Training Purposes

Pure simulations, even without a data acquisition device, offer excellent opportunities to test measuring or process control experiments that have been developed on the PC. In these cases, a signal generator module, or several of them, is substituted for the measuring device. By combining signal generator modules

with mathematical modules, complex stimuli can be generated. For example, a sine or rectangle signal might be overlaid by a noise signal or by further sine, rectangle, or saw tooth signals. Even signals that have previously been saved to files may be retrieved and used again as stimuli using the file I/O module.

You can use ***ServiceLab*** in training courses, as trainees can directly observe the effects and results of data acquisition and process control systems.

Publication

All the resources provided by Windows are at your disposal for publication purposes. Not only the measured results, but also the entire experiment setup can be published comprehensively and professionally. ***ServiceLab*** can supply the worksheet diagram itself, or the graphic display of the measuring results, directly to Windows WordPad, Microsoft Word, or PageMaker. ***ServiceLab*** provides integrated publishing tools to print the worksheet, graphic or numerical data displays, captions and explanatory text passages.

Custom Functions

As a service to customers who have to cope with highly specialized tasks, ***ServiceLab Ltd.*** will develop custom function modules and other software modifications on request to meet individual demands. For instance, specified mathematical operations or options concerning the graphic presentation can be implemented or modified as required, and further data exchange interfaces can also be supplied.

An Extensions Tool Kit is available for experienced C programmers who wish to design their own modules. Contact your dealer for more information.

Integrated Help System

In most situations, it is not necessary to refer to the complete manual, since almost any problem can be solved using the online help system.

The context-sensitive help system provides the user with detailed instruction on hardware settings and software options, and it also supplies background information on measuring technology topics like FFT/spectral analysis.

Conclusions

In combination with one of the established PC measuring and process control devices, the ***ServiceLab*** system is a powerful tool for data acquisition, process control and simulation.

4. Installation

4.1. System Requirements

ServiceLab works with most personal computers available today. The minimum software and hardware requirements your PC needs to run ***ServiceLab*** successfully are listed below. To get the best performance from the software, especially when more than one Windows applications is to be run, we recommend additional hardware resources.

Minimum Requirements

- A personal computer with an Pentium class processor, a standard keyboard, a mouse or similar pointing device
- 64 MB memory (RAM) for Windows 98, 128 MB for NT/2000/XP
- 40 MB of free hard disk space
- CD-ROM Drive for installation
- A monitor and a VGA display adapter , 1024 x 768 resolution
- One parallel interface (Centronics) is required for dongled (hardware key lock) versions of the product.
- Windows 95/98 or Windows NT/2000/XP

Recommended Configuration

- Pentium II class or better PC
- Additional memory (RAM) (the amount of memory determines the display capability of the Chart Recorder and Y/t Chart modules)
- Free hard drive space to install optional components, such as DataSockets
- High resolution color monitor (e.g. 1024 x 768)
- Super VGA display adapter supported by Windows
- Software, keyboard, mouse, hard disk, CD-ROM drive, and interfaces as described above
- Serial interface (RS232)

All printers and plotters supported by Windows can be used with ***ServiceLab***.
No data acquisition hardware is *required* to run ***ServiceLab***. To acquire input or output analog signals one of the A/D or D/A devices that are supported by ***ServiceLab*** must be installed. Please refer to the Hardware Installation Manual or the online help for details about the installation of your hardware.

4.2. Setting Up *ServiceLab*

Preparations

1. Make sure that your ***ServiceLab*** package is complete. It should contain a CD-ROM disk and the registration card.
2. Make sure that there is at least 40 MB of free space on the hard disk where you are installing ***ServiceLab***.
3. You must be running Windows. ***ServiceLab*** will not install from the DOS prompt.
4. Insert the CD-ROM into your CD-ROM drive.

If you received the CD-ROM as the installation media, and your computer does not have a CD-ROM drive, you can use another computer (with a CD-ROM drive and a diskette drive) to make diskettes. Insert the CD-ROM, and follow the installation/make diskettes prompts. You will need 10 or 11 blank, formatted 3½" diskettes.

We strongly recommend *that you read the* ***README.TXT*** *file before you start with the installation. This file contains a* ***detailed installation instruction***.

Never install ServiceLab 3.5 (only S5-functionality) under Windows NT/Windows 2000. A system breakdown or even a loss of datafile might occur.

The S7-Interface have to be installed in order to give ServiceLab 7.0 its full functionality (read the README.TXT).

Starting the CD-ROM Installation

1. Insert the CD-ROM disk into your drive.
2. The CD menu will offer you several choices. For detailed informations read the README.TXT file on your CD.
3. Select Installation
4. Select Install to run Setup.

Setup Summary

The installation program will …

… Ask for the serial number which was provided for a new or upgraded installation (use your current number to re-install)

… Give you the opportunity to specify the directory and other installation options

… Allow you to specify the data acquisition driver to install.

… Check if the specified directory exists, and create it if necessary.

… Check if there is enough free space on your hard disk. If not, you will be asked to enter another drive or to cancel setup.

… Copy all the ***ServiceLab*** program files to the drive and directory.

… Create a ***ServiceLab*** program group in the Windows Program Manager. If the group already exists, it will be opened.

… Create various program items within that group.

… Add the appropriate hardware driver command lines to the [386Enh] section of the `SYSTEM.INI` file if you specified a ***ServiceLab*** driver with a virtual device driver (Windows 98), or load kernel mode driver (*.KMD) for Windows NT/2000/XP.

… Add appropriate items to the Windows Registry

… Optionally, install DataSocket Client and Server software

Completing Setup

If your data acquisition device does **not** require a virtual device driver, you can exit the installation procedure and use ***ServiceLab*** immediately.

If you have installed a ***ServiceLab*** version that includes a virtual device driver, Windows may need to be restarted so that the changes made to your system can take effect.

If you choose Exit Installation to use your original Windows configuration, ***ServiceLab*** is ready to be used, but can only access any newly installed device drivers (if required) after you exit Windows and restart it. If you choose Restart Windows, the program will exit Windows completely and restart it.

☝ *With some data acquisition devices it may be necessary to modify the configuration of Windows. Please refer to the documentation that comes with your hardware, or to the Software Installation section pertaining to your hardware in the Hardware Installation Manual.*

4.3. Hints for PC Hardware Configuration

PC's used for data acquisition systems must fulfill other requirements than computers used as **office systems** or **for games.**

This means there are different considerations when installing a measurement system.

The following hints will help if your PC hardware has hardware problems.

Often these problems are related to the following components or functions:

- Power Management

  The Power Management System of some PCs sometimes obstructs the measurement. Please completely disable the Power Management option in the PC BIOS. You may also have to disable the "Support of Advanced Power Management" in System/Device Manager/Hardware Components.

PCMCIA / PC-Cards and USB based devices may have additional power management settings. Disable all applicable power management to prevent Windows from stopping your devices while running.

- Windows Time Zone Settings

  Please disable the Time Zone property "Automatically adjust clock for daylight savings changes" in the Window's Date/Time Properties. If ***ServiceLab*** is running when the operating system changes the clock time, it pauses until the user clicks on the Dialog Box to acknowledge the change. In addition ***ServiceLab*** will not have the correct start time for the Experiment. ***ServiceLab*** only checks the PC clock time at experiment start.

- Graphic Card Drivers

  New drivers from some Graphics Card manufacturers are often optimized for maximum speed (e.g. to reach high performance in PC games). The driver overrides and obstructs the measurement running in the background. When in doubt, do not use the driver of the card manufacturer but use the original Standard VGA or SuperVGA driver shipped with Windows by Microsoft. Sometimes, there is a newer driver available from your graphics card manufacturer that fixes problems. Please check with your manufacturer for the latest drivers.

- Printers

  Several printer drivers also disturb the data acquisition. If you experience any problems, use a printer that is supported by the original Standard Printer Driver of Microsoft. Often these standard drivers support a complete family of drivers. For example, you can control the HP LaserJet family with the 'HP LaserJet Series II' driver from Microsoft.

- Resource Conflicts

  Please pay attention to resource conflicts between the hardware components of your PC. Often the data acquisition hardware uses the same IRQ or DMA addresses as Sound Cards, Network adapters and other devices. In case of doubt, remove the Sound Card from your system or, if it is fixed in a notebook, disable it in the BIOS. Simply removing the driver (!) in Windows 98 will not solve the problem.

5. *ServiceLab* Versions

ServiceLab is available with optional features. The table below lists the features available. Please contact your dealer or distributor for more information about ***ServiceLab***. Note that this User Guide includes information about optional features.

⇨ *Optional features may vary by country. Check with your dealer or distributor for details.*

The chart below shows the versions and which modules are provided with each version.

Group	Module	Basic Version	Optional
Input/Output	SIMATIC S7 read	X	
	Analog Input		X
	Analog Output		X
	Digital Input		X
	Digital Output		X
	Counter Input		X
	Frequency Output		X
	RS232 Input	X	
	RS232 Output	X	
	ICOMs Input	X	
	ICOMs Output		X
	IEEE488 Input		X
	IEEE488 Output		X
	DDE Input	X	
	DDE Output	X	
	IVI Devices		X
	MODBUS Devices		X
Trigger	Combi Trigger	X	
	Pre/Post Triggering	X	
	Start/Stop Triggering	X	
	Trigger on Demand	X	
	Sample Trigger	X	
	Relay	X	
Mathematics	Formula Interpreter	X	
	Arithmetic	X	
	Trigonometry		X
	Scaling	X	
	Different /Integration	X	
	Logical Operations	X	
	Slope Limitation	X	
	Bit Logic	X	
	Gray Code		X
	Flip-Flop		X
	Channal Comparison	X	
	Reference Curve	X	
Statistics	Statistical Values	X	
	Position In Signal	X	
	Histogram	X	
	Regression	X	
	Counter	X	
	Minimum/Maximum	X	
	Pulse Width Analysis		X
	Sort Channels		X
	Check Reference Curve	X	
Control	Generator	X	
	Switch	X	
	Coded Switch		X
	Slider	X	
	PID Control		X
	Two-Point Control		X
	Time Delay	X	
	Latch	X	
	TTL Pulse Generator	X	
	Global Variable Read	X	
	Global Variable Write	X	
	Signal Router		X
	Blocktime Info		X
	Stop	X	

Group	Module	Basic Version	Optional
Signal Analysis	Filter		X
	Correlation		X
	Data Window		X
	Elektirc Characteristics		X
	Harmonic Distortion		X
	Period Check		X
	FFT		X
	Polar/Cartesian		X
Display	Y/t Chart	X	
	X/Y Chart	X	
	Chart Recorder	X	
	Analog Meter	X	
	Digital Meter	X	
	Bar Graph	X	
	Status Lamp	X	
	List Display	X	
Files	Read Data	X	
	Write Data	X	
	Backup Data	X	
	ODBC In	X	
	ODBC Out	X	
Data Reduction	Average	X	
	Block Average	X	
	Separate	X	
	Merge/Expand	X	
	Cut Out	X	
	Shift Register		X
	Time Slice		X
	Circular Buffer	X	
Network	DataSocket In		X
	DataSocket Out		X
Special	Black Box	X	
	Ex/Import Black Box	X	
	Event Driven Actions	X	
	Message	X	
	Send E-Mail	X	
	Time Base	X	
	Signal Adaptation	X	

6. New in *ServiceLab* Version 7.0

Below, you will find an overview of the most important additions and changes for the current ***ServiceLab*** Version. Please also read the README.WRI file for additional changes made after this book was printed.

We have described the most important changes and additions to this ***ServiceLab*** version on the following pages.

6.1. General

Replace Module

You can Replace modules by other modules of similar configuration. Use the new command and select one of the available replacements from the list.

Start-Up dialog for Global Strings / Variables

Use the new Menu Command to configure the order in the list of strings/variables that must be entered at the start of an experiment.

Import Global Strings / Variables

In addition to the *.VAR file format (generated by the global variables export function) now you can import standard file formats *.CSV, *.TXT (Excel format) with the command on the **Options** Menu. For the import an Excel table separated by commas is needed.

In this way you can configure the global variables in an Excel table, where it is easy to create similar configurations with Copy/Paste; ensure that you do not enter the same entries several times into the global variable dialog box.

Action/Layout Link Check

The renaming of modules which are referenced in Action modules or layout links will now be handled appropriately. All action modules and layout objects with references to the renamed module will use the new module name. You no longer have to manually rename these links.

Also, deleting layout pages updates any links in action modules to the new Layout page numbering.

Block Move of Modules and Signal Connections

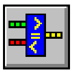
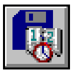
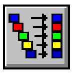
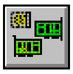
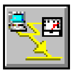
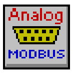
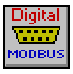
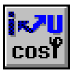
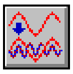
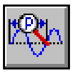
You can select a block of Modules and move them to another part of the Worksheet. All Connections are also moved.

User Defined Colors

If any user-defined colors are used in any dialog, such as for the layout background color, then these colours can be used in all other colour setting dialogs.

6.2. New Modules

See the Module Reference Guide for details of each new module.

	Module	Module Group
	Channel Comparator	Mathematics
	BlockTime (optional)	Control
	Shift Register (optional)	Data Reduction
	Multi-Speed Analog Input	Input/Output (only available for selected drivers)
	ICom Input	Input/Output
	ICom Output (optional)	Input/Output
	MODBUS Analog Input/Output (optional)	Input/Output
	MODBUS Digital Input/Output (optional)	Input/Output
	Electric Characteristics (optional)	Signal Analysis
	Harmonic Distortion (optional)	Signal Analysis
	Period Check (optional)	Signal Analysis

6.3. Module Changes

Statistical Values

The new Peak-to-Peak function computes the difference between the maximum and the minimum of a block.

Scaling Module: Unit Conversion:

This new option converts the input value into one of several unit systems ***ServiceLab*** allows you to convert from one measurement system to another without the knowledge of the necessary conversion constant. Conversions are included for temperature, volume, pressure, length, mass, velocity, and more.

RS232 Interface (RS232 Input- and RS232 Output Modules)

Improved debugging and setup features are included in the RS232 monitor. Up to 30.000 characters of text are stored in the internal monitor buffer. The Format String Debugging function is a useful tool for detecting errors in Format Strings or to help in creating a Format String. A basic function of the Format String-Debugging is to mark Parser activities with colored characters. The parser divides the series of characters received into parts corresponding to the settings in the Format String and assigns different colors to each of these elements.

Regression

The performance of the Regression Modules was improved. The block size of an input block does not change, and the computation time per regression calculation was more than halved.

Integration/Differentiation Module

The Differentiation/Integration module now allows a control input to reset the module based on the control signal.

Chapter 2: Getting Started

1. Basic Techniques

Chapters 2 and 3 are designed to give you a quick first look at the program and to let you start experimenting with it.

This chapter discusses the following subjects:

- How to start ***ServiceLab***.
- How to obtain online help while working with ***ServiceLab***.
- How to create your first worksheet and become familiar with ***ServiceLab*** 's basic functions.

You should be familiar with the basic techniques needed to operate your PC, DOS commands (such as those concerning drives, directory changes and file management), mouse operations and Windows fundamentals (like using menus or window features, etc.).

If you require additional information, please refer to your Windows User's Guide and the documentation that comes with the corresponding software and devices. The online tutorial supplied with Windows helps you to learn basic mouse techniques.

ServiceLab uses features common to most Windows applications:

- A menu structure with pull-down lists.
- Scroll within windows using vertical and horizontal scroll bars on the right and the lower window borders.
- Drag elements across the working area by selecting the element and moving the mouse with the **left** mouse **button** pressed.
- Drag groups of modules by selecting the group using the **left** mouse button to click and drag a selection box. The **left** click on the selected area and drag it to the desired location.
- Dialog boxes provide option buttons, list boxes and text boxes to select options and to enter parameters.

Right Mouse Button Functions in the Worksheet Window

⇨ *The **right** mouse **button** has multiple functions within **ServiceLab**, which are explained here and in Chapter 3.*

When the mouse cursor is on a module in the worksheet, you can display a context-sensitive pop up menu by pressing the **right** mouse button. The following menu items are displayed:

- Delete Module
- Delete Input Channels (if module has any input channels connected)

- Delete Output Channels (if module has any output channels connected)
- Cut (if module is selected)
- Copy (if module is selected)
- Replace Module
- Search Module
- Module Documentation (extended description of selected module)
- Properties (Module dialog box for selected module)
- If the mouse cursor is over a free area of the worksheet, the pop up menu has the following entries:
- Colors
- Paste (insert previously copied or cut worksheet components at the position of pointer)
- Properties (general worksheet settings)

  To select the window mode:
  - Control Sequencer
  - Display
  - Worksheet
  - Layout

Worksheet Documentation Tool:

- √ Edit Documentation (enables the documentation tool)
- Create Documentation
- Delete Documentation
- Documentation Properties

Delete a Data Channel - Two separate clicks (not a double-click!) with the **right** mouse button on the connection line between a module output and another module's input deletes that data channel

Right Mouse Button Functions in the Control Sequencer

Click with the right mouse button on the background to open the popup context menu to switch to the other window modes (Worksheet, Layout, Display).

Right click on a flowchart junction to open a menu with the commands:

- New (Flowchart or Action)
- Comment Flowchart
- Set Start Flowchart (The start flowchart is marked by an added “start”)
- Load Flowchart
- Delete Flowchart (with an additional security request)

For Action junctions the commands below are available:

- New Action)
- Edit Action

- Delete Action

Right Mouse Button Functions in the VITool Layout Window

If the mouse cursor is on an object in a VITool Layout Window, you can display a context-sensitive pop up menu with the following items:

- Cut
- Copy
- Delete
- Up
- To Front
- Down
- To Background Properties (Graphic Object)

If the mouse cursor is on a free area of the Layout Window, the pop up menu has the following entries:

- Paste
- Object (to insert a new object)
- Zoom
- Full Screen
- Delete Layout page
- Switch to…
  - Worksheet
  - Displays
  - Control Sequencer
- Global Layout Properties
- Page Layout Properties

Right Mouse Button Functions in the Display Window

Display Windows: If the mouse cursor is on a display window, the pop up provides the window menu options (useful if the Menu Bar is hidden)..

Right Mouse Functions if the pointer is on Module, Function or Status Bar

- Module, Function or Status Bar (32-bit Version only): You can use the **right** mouse button to activate or deactivate the Module, Function or Status Bar. Activated bars are marked with a checkmark. The Module Bar display can be defined by user (number of rows/columns).
- Configure the Module Bar - Click on a Module Bar icon with the **right** mouse button to assign any of the modules available in ***ServiceLab*** to that button

- You can change the relative size of the Module Bar by choosing from the selection of settings for the configuration of the Module Bar (1x40, 2x20, 4x10, etc.).

Configuring Hardware Module Input/Output Channels

- Double-click the icon of an active channel on the Channel Selection Bar with the **right** mouse button to deactivate that channel.

2. Starting *ServiceLab*

2.1. Starting *ServiceLab* with a New Worksheet

From the Windows Start Menu

Click on the Windows Start button. Select Programs, then the ***ServiceLab*** program group. Select the ***ServiceLab*** icon from that group to start the program.

From the Windows Program Manager

Double-click the ***ServiceLab*** Icon displayed in the ***ServiceLab*** program group of the Windows Program Manager. When you installed ***ServiceLab*** on your hard disk, a new program group ("***ServiceLab*** ") was automatically created.

2.2. Starting *ServiceLab* with an existing Worksheet

From the Windows Program Manager

- If you prefer to keep a program startup option without a worksheet, first copy the ***ServiceLab*** icon. Select the icon, and press the F8 function key, or choose Copy from the File menu.
- Select either of the two icons (one mouse click), and press the ALT+ENTER keys or choose Properties from the File menu.
- Type the complete worksheet file name (including drive, directory, and extension) after the ***ServiceLab*** command in the Command Line box. For example:

`"C:\Program Files\`***SERVICELAB***` 7.0\`***SERVICELAB***`.EXE" D:\TESTS\TEST1.DSB`

- In the Description box, type a description that identifies the worksheet that will be loaded onto the work area.
- Press ENTER
- Use this method to set up several icons to automatically open various worksheets.

You will find additional information on Automatic Program Start options in Chapter 6 of this User Guide.

3. Experiment Setup and Time Bases

General parameters for data acquisition and measurement control are set in the Experiment Setup dialog. You can set the

- Global Sampling rate per channel
- Global block size
- Global settings for Analog Output and Digital Output
- Global clocking for the driver
- Disk Streaming options
- Driver specific settings, including driver buffer, acquisition mode, etc.

See Chapter 4: 1.4.8 Experiment Setup... on page 4-25 for more details.

In addition to the Global Sampling Rate, ***ServiceLab*** supports special drivers that may also be able to generate their own clock. The NI-DAQ driver for National Instruments devices is one such special driver.

The Time Base Setup, in the Experiment Menu, allows you to review each of the available time bases, and to configure them in one place. Various modules which can generate data, such as the Switch or Slider Modules, have a user settable option to choose the time base, allowing you to synchronize the output with hardware generated data.

4. Documenting your Worksheet

In addition to the module name and short description you can add an extended description to each module inserted on a flowchart. You can also create documentation frames that are permanently shown on the worksheet background, behind or around one or more modules or just in an empty area.

Modules Documentation

The popup context menu, opened by right clicking the mouse over a module shows the Module Documentation choice. Select this command to create a description with up to 256 characters.

Flowchart Documentation

In addition to the module documentation, you can insert information to the flowchart in text boxes, which are shown permanently on the background of the worksheet. A right mouse click on an empty area of the worksheet background opens the popup context menu that offers several commands to **Edit**, Create and Delete documentation frames where you can enter up to 256 text characters to be displayed. The Edit Documentation command activates (√) the documentation function. The Properties command enables you to modify the look of the frame (background, font and frame colors) and provides an edit area to insert any text up to 256 characters. You can choose any available font to apply to all of the charac-

ters. Use the left mouse click to move (“catch” the upper left corner) or resize (“catch” the lower right corner) the boxes.

A maximum number of 256 frames may be placed on each worksheet.

☝ *This new feature allows you to structure your flowchart with colored frames. Put modules of the same functional group into boxes with the same color (see the online help for a colored example).*

5. Context Menus

Right Mouse Click on Module

If the pointer is over a module on the worksheet, you can display a popup menu by clicking the right mouse button. The following menu items are displayed:

- Delete Module
- Delete Input Channels (depending on position of pointer)
- Delete Output Channels (depending on position of pointer)
- Replace
- Cut
- Copy
- Delete
- Search Module
- Module Documentation (Description of the lower module)
- Properties (Dialog box for the module beneath the mouse pointer)

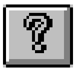
Context Menu: Right Mouse Click on Worksheet Background

If the pointer is on a free area of the worksheet, the popup menu has the following entries:

- Colors
- Paste (Insert components of worksheet at the position of the mouse pointer)
- Properties (general worksheet settings)
- (to select the window mode)
- Control Sequencer
- Display
- Worksheet
- Layout
- (Worksheet Documentation Tool)
- ✓ Edit Documentation (enables the documentation tool)
- Create Documentation

- Delete Documentation

6. Documentation Properties Using the *ServiceLab* Help System



*Click on this Button to call up the **ServiceLab** Online Help or choose Help from the Main Menu and select Index or one of the other available options.*

You can usually obtain information on the function you are currently using by pressing the F1 function key or by clicking the Help button found in many dialog boxes. Then, either specific information on the current function, command or dialog box, or the Help Index will be displayed.

You can obtain information on how to use the Windows Help system itself by pressing the F1 function key while using a Help window or by choosing Using Help from the Help menu.

7. Creating your First *ServiceLab* Worksheet

Follow this tutorial to create a simple worksheet and to learn about the basic elements and functions of ***ServiceLab***.

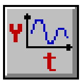
To start the program, double-click the ***ServiceLab*** icon in the ***ServiceLab*** Program Group of the Windows Program Manager.

The ***ServiceLab*** screen will appear, displaying the Title Bar and the Main Menu Bar, the Function Bar below them, and the Module Bar on the left of the window. (These elements of the ***ServiceLab*** screen are described in Chapter 3.)

Press the F1 function key (or the Help button while working in a dialog box) to obtain online help. If you prefer to follow these instructions on screen, press F1 now, and choose Creating your First Worksheet from the Help Index page.

On the left hand side of the ***ServiceLab*** screen you can see the Module Bar. It displays a selection of icons that represent modules frequently required in worksheets.

*Place the mouse pointer on this Module Bar icon. It represents a Generator module. Click the icon with the **left** mouse button. The name of the module the mouse pointer is pointing at is displayed in a small window above the module icons.*



*In the same way, choose the Y/t Chart module by clicking its icon on the Module Bar with the **left** mouse button. You have now integrated these two modules into your worksheet; their symbols appear in the work area.*

Any module can be installed either by clicking the corresponding icon on the Module Bar, or by choosing it from the Modules menu. While the Module Bar can only offer a limited selection of icons, the Modules menu provides the complete list of available modules.

When you install a module from the Display group of the Modules menu (for example, a Y/t Chart module), an additional icon will appear at the bottom of the screen.

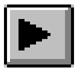
The two modules in the worksheet must now be connected by data channels so that data can be transferred between them.

To connect them, simply move the mouse pointer to the Y/t Chart module symbol, press the **left** mouse button, and drag the module symbol to the Generator module symbol (keeping the mouse button pressed down) until the output (O) and input (I) symbols touch. When you release the mouse button, ***ServiceLab*** will automatically connect the two modules and route the wires.

You can also connect two modules without moving the module symbols – you'll do that in a few minutes.

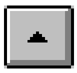
The data channel is now complete; the output of the first module is connected to the input of the second. The experiment can begin.

At the top of the ***ServiceLab*** screen, below the Main Menu Bar, you can see the Function Bar. It contains icons that provide easy access to frequently used functions. When the mouse pointer is pointing at a Function Bar icon, a QuickInfo tag with the name of that function will appear. Just click the icon representing that function.



Use the **left** mouse button to click this icon on the Function Bar – the first one on the left or press F5. This will start the experiment, and soon the Generator module will generate a signal.

The signals and results of measuring processes can be displayed graphically using modules from the Display group. They consist of two elements each: the worksheet symbol, which is integrated into the worksheet and connected to the other modules by data channels, and the Display Window, which initially appears minimized as an icon at the bottom of the computer screen, and which you must separately restore (or "open") to see the display during an experiment.

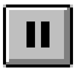


Open the Y/t Chart Display Window using the **left** mouse button, either by clicking this Function Bar icon (it represents the Show Display Windows command from the View menu) or by double-clicking on the display window icon at the bottom of the desktop.

The Y/t Chart Display Window appears, and you can observe the signal generated by the Generator module as it is shown on the display.

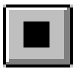
Before you perform the next steps, please drag the Y/t Chart Display Window to a position above this Help window, so that it does not hide any elements of your worksheet. It may be necessary to adjust its height first. You can drag a window

by clicking its Title Bar with the **left** mouse button and moving it to its new location with the mouse button pressed down.



By alternately clicking this Function Bar icon with the **left** mouse button you can pause the running experiment or resume it at the same stage at which you interrupted it. Pressing CTRL+F6 on your keyboard has the same effect.

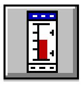
Click the **right** mouse button on the Y/t Chart Display Window screen: the Color dialog box appears. Select a new color for the display background by clicking the colors on the palette and pressing OK.



Now stop the experiment. You can either click this icon on the Function Bar or press CTRL+F5 on your keyboard.

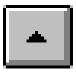
If you cannot see the Y/t Chart module symbol (in the work area) because it is hidden behind the display window, drag the window to one side or reduce it to an icon by clicking the Minimize button (the down arrow in the upper right-hand corner of the display window).

Use the **right** mouse button to double-click the Y/t Chart module symbol on the worksheet to open a dialog box. Select Delete Module and press OK to delete the Y/t Chart module from your worksheet.

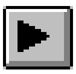


Now add the Bar Graph module to your worksheet by clicking its icon on the Module Bar with the **left** mouse button. The module symbol appears in the work area, and the icon representing the corresponding display window will appear on the lower edge of the desktop.

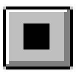
Connect the input of the Bar Graph module symbol with the output of the Generator module symbol as described above.



Open the Bar Graph display window either by clicking this Function Bar icon or by double-clicking the display window icon at the bottom of the desktop.



Start the experiment again; the Generator signal will appear in the Bar Graph display window.



Stop the experiment,

and click the Module Bar icon representing the Digital Meter module. The module symbol appears on the worksheet next to the Bar Graph module symbol, and the corresponding display window icon appears at the bottom of the desktop.

Move the Digital Meter module symbol around the worksheet by clicking and holding the **left** mouse button while you drag it to various locations.

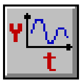
For example, drag it below the Bar Graph module symbol. ***ServiceLab*** will arrange the blocks evenly according to the grid settings defined in the Window Setup dialog box from the Options menu.

The quickest way to connect the Digital Meter module to the Generator module is to “tap” the existing data channel between the Generator module and the Bar Graph module. To create a branch, use the **left** mouse button to click anywhere on the data channel between the two module symbols. The mouse pointer takes the shape of a hand holding a plug. Place the tip of the plug precisely onto the input symbol (I) of the Digital Meter module symbol, and click the **left** mouse button again. This establishes the connection, and the Autorouter automatically finds the correct path for the new data channel segment.

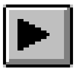
You can now start, pause, and resume the experiment. Practice changing the color of the display by double-clicking the Digital Meter icon at the bottom of the screen, to change the color of the display as described above.

The default signal generated by the Generator module is a square wave. Double-click the Generator module symbol with the **left** mouse button. You can select various settings in the dialog box to define the signal to be generated. Refer to the Module Reference Guide or press the F1 function key to obtain information on the parameters.

Click the Sine button in the Wave Form box, and then click the OK button. The Display modules will display the selected signal type.

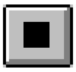


The Y/t Chart module can be used now to visualize the sine wave. Since you previously deleted the Y/t Chart, click on the Module Bar to bring the Y/t Chart back onto the worksheet. (If your experiment is still running, you must first stop it before making changes in the experiment setup.)

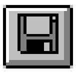


Create another data channel branch to connect the Y/t Chart module symbol, and then start the experiment again.

You should **Save** your first worksheet now, so that you can use it to try out some more of ***ServiceLab****’s* options later on.



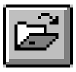
First, stop the current experiment,



And then click this Function Bar icon with the **left** mouse button. It represents the Save command from the File menu.

A dialog box appears. In it, the File Name box displays a list of demo worksheet files that were copied to the ***ServiceLab*** directory during the setup procedure. These files will give you examples of the wide range of measuring and data acquisition tasks that can be solved by ***ServiceLab***. You can open, run, modify and re-run them all later. Their File Info box contains a description of each worksheet.

Type a file name of your choice (using no more than eight characters) in the File Name box; for example, type TUTOR1. Choose the OK button, and your worksheet will be saved as TUTOR1.DSB in the ***ServiceLab*** directory. (***ServiceLab*** automatically adds its standard extension .DSB.) The ***ServiceLab*** window Title Bar now shows the file name.



To open this (or any other) worksheet file later, click the File Open icon on the Function Bar with the **left** mouse button. This icon is a shortcut to the Open command on the File menu.

Congratulations! You have successfully finished the ***ServiceLab*** basic lesson and are now ready to begin working with ***ServiceLab***!

The next time you have a question or need help, you can

- Read these instructions again
- Find the answers in other chapters of the ***ServiceLab*** documentation
- Use Online Help. You can obtain Online Help by pressing the F1 function key whenever you need help; or use the Search function in the Help window

Unless you prefer to continue experimenting with ***ServiceLab***, exit the program now by double-clicking the Control Menu box in the upper left corner of the ***ServiceLab*** window, or by pressing ALT+F4 on your keyboard.

Chapter 3: Creating an Experiment Setup

This chapter describes ***ServiceLab***'s basic elements and functions used to set up a data acquisition experiment.

Read these pages at your computer so that you can try out all the functions provided by ***ServiceLab***. This chapter can also be used as a reference.

This chapter addresses the following topics:

- The elements of an experiment setup
- The elements of the ***ServiceLab*** screen and how to use them effectively
- A brief overview of the module groups
- A systematic approach to a data acquisition task to be solved on screen.
- An overview of the VITool Layout windows

1. The Elements of a Worksheet

The worksheet graphically displays the complete experiment setup or measurement procedure, including all the modules and data channels. The maximum size of a worksheet in pixels is 2000 (vertically) by 2000 (horizontally). It is independent of the screen resolution.

1.1. Modules

A module represents a functional element in the ***ServiceLab*** experiment setup (worksheet). A worksheet can contain up to 256 modules.

The functions symbolized by the modules comprise all the operations required for an experiment:

- Data acquisition (by a data acquisition board) or signal generation (simulated by a software generator)
- Data analysis, evaluation and processing (mathematics, statistics, control, trigger and other functions)
- Presentation on screen (display instruments) or export for documentation purposes (printer, metafile, etc.).

Most modules can be configured with up to 16 inputs and outputs.

A module can be installed on the worksheet by choosing it from the Module menu or by clicking the icon on the Module Bar.

You can find detailed information about the Module menu functions in Module Reference Guide. The Module Bar is described in detail on page 3-21 in this chapter.

Icons in the Module Bar appear slightly different from the worksheet symbols. Additionally, modules from the Display module group have a display window symbol.

Module Bar Icons

On the Module Bar, the modules are represented as simplified icons at a slightly reduced scale. The name of the module selected by the mouse is displayed above the Module Bar.

- Click the Module Bar icon with the **left** mouse button to add that module as a symbol to the worksheet, where it takes the first available free space. The exact position depends on the Spacing value entered in the Window Setup box of the Options menu.
- Click any Module Bar icon with the **right** mouse button to assign any of the available ***ServiceLab*** modules to that position in the Module Bar (see page 3-21 in this chapter for a complete description of the Module Bar and techniques to customize it.)
- The Module Bar can only display a limited selection of the modules available in ***ServiceLab***. The exact size of the Module Bar depends on the screen resolution of your PC. All the available modules can be accessed from the Module menu. Please refer to Module Reference Guide of this manual for complete module documentation.

Worksheet Symbols

In the worksheet, modules are represented as complete symbols. These symbols display each module's name and the input and output channels you have selected for it.

- Use the **left** mouse button to double-click on the symbol to open the dialog box to configure the module.
- Use the **right** mouse button to double-click on the symbol to open the dialog box to delete the module from the worksheet or to delete its input or output data channels.
- Click and hold the **left** mouse button to drag and drop the symbol to any position on the worksheet (depending on the Spacing value entered in the Window Setup box of the Options menu).

⇨ *When positioning modules manually in the worksheet, leave enough space between the module symbols for data channels to be created later. If you try to connect two modules and there is not enough space to arrange the data channels, an error message will appear: "Connection is not possible."*

- The modules from the Display module group provide an additional display window, which initially appears minimized at the bottom of the screen.

Module Manipulation by Keyboard

The modules on the worksheet can be manipulated in various ways. The module symbols on the worksheet can be dragged about, connected by data channels,

configured, or deleted. The last two of these manipulations can also be done using the keyboard.

First, select the module. Only one module in the worksheet can be selected and manipulated at a time. When a module is selected, the Module Name Title Bar is highlighted in an inverse color.

- To select a module, click it once with the **left** mouse button, or press the TAB key on your keyboard until that module is selected.
- When you press the ALT+ENTER keys, the module configuration dialog box appears. Press the TAB or SHIFT+TAB keys to move from one field or button to another; select items by pressing the arrow keys, the SPACE and ENTER key.
- Note: Channel selection can only be done using the mouse.
- To copy setting for the selected channel to the other activated channels, use the F7/F8 function keys. This procedure can only be done using the keyboard.
- To delete the selected module from the worksheet, or to delete all the input and/or output channels of that module, press the DEL key. In the dialog box that then appears, select the desired option, or choose Cancel, and press ENTER.

1.2. Data Channels, Junction Points

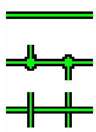
A data channel is the connection between the output of a module and the input of another module. Data is transferred between the respective modules via these connections.

A branch is a data channel segment that branches off from another data channel at a junction point.

Branches allow you to connect the output of one module to the inputs of several other modules.

By creating branches each module output can be connected to up to 16 inputs of other modules.

In the worksheet, lines like these represent data channels, branches and junction points:



Data channel (wire)
Branches and junction points
No connections

You can choose the colors of the wires using the Colors command from the Options menu. Different colors can be specified for the wire cores and the wire sleeves.

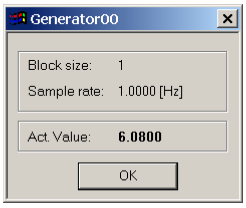
When you connect the modules, the Options Autorouter menu function allows the following.

- When the Autorouter is active, ***ServiceLab*** automatically finds the correct paths for the data channels. ***ServiceLab*** ensures that the data channels do not run across modules or hide other data channels. A control window in the Status Bar displays the progress of the autorouting operation.
- When the Autorouter is not active, you determine the paths of the data channels manually.

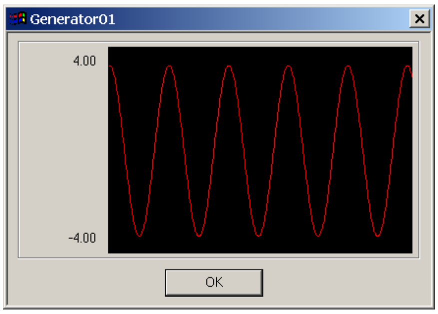
Channel FIFO Status while measurement is running

In addition to the Animation options (View Menu), there are three ways to monitor the flow of data between modules while the measurement is running. This is a useful set of features for ensuring that the worksheet logic is working as designed.

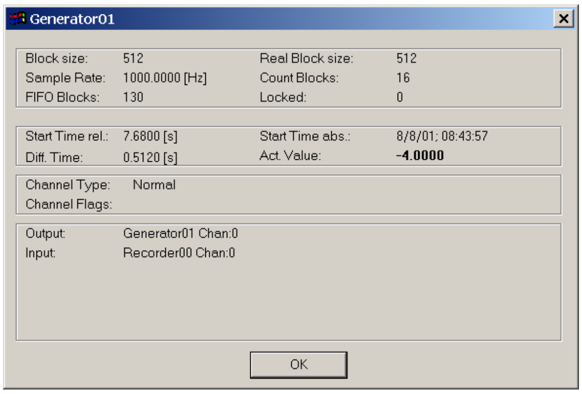
- Use the left mouse button to click on a data line. This simple display shows the data value and block size.



- Press on the `Shift` key and click on the data line with the left mouse button. This auto scaling chart displays all of the data in a block.



- Press the `Control` (Strg) key and click on the data line with **left** mouse button to display the status of the data channel during measurement.



1.2.1 Creating Data Channels or Branches

The Quick Way

To connect a module, simply drag it against the module to which it is to be connected until the output (O) and input (I) symbols touch. When you release the mouse button, ***ServiceLab*** will automatically connect the two modules and route the wires (whether the Autorouter option is active or not).

This procedure works with modules with any number of input or output channels, and it is very useful when connecting modules with multiple inputs and outputs.

It works when both modules are configured differently, when different channel numbers have been selected, and when some of their inputs or outputs are already connected to other (i.e., a third) modules.

For example, you can activate four output channels of a Generator module, then connect two of them to Display modules, and the remaining two to modules from the Signal Analysis group.

Once a connection has been established between two modules, no further connections (between the other – still unconnected – outputs and inputs of these two) can be created in this simple way. You must then proceed as described below.

With the Autorouter Option ON

Click the **left** mouse button once at the point where you wish the data channel to begin – the output symbol (O) of a module or – for a branch – any position on the wire. The mouse pointer then changes into a plug symbol.

Then place the **tip** of that plug symbol on the input symbol (I) of another module. Note that the input of the second module must be open. While you do this, a thin black line is drawn from the starting point of the connection.

Click the **left** mouse button again, on the input symbol at the end of the connection, to establish the connection.

- Undo last Step**:** use ALT+BACKSPACE to remove the last connection and restore the worksheet.
- To cancel the process, click the **left** mouse button once anywhere outside the input symbol.

With the Autorouter Option OFF

Click the **left** mouse button once at the point where you want the data channel to begin – the output symbol (O) of a module or – for a branch – any position on any wire. The mouse pointer then changes into a branch symbol.

Draw the new data channel by moving the mouse. While creating each segment, you can lengthen or shorten it only in the vertical or horizontal direction indicated by the branch symbol. You need not move the mouse pointer exactly along the future track of the channel.

Click the **left** mouse button again to freeze the length of the data channel segment you have just created and switch to the other axis (horizontal or vertical) for the next segment.

When the data channel hits a module, you must guide it around it.

When the tip of the new data channel is aligned with the input symbol of the desired module input, click on the input symbol to complete the data channel connection.

- To undo the last segment, click the **right** mouse button once.
- To cancel the process, double-click the **left** mouse button anywhere.
- To undo the last data channel connection, use the ALT+Backspace key combination.

To Create a Branch

When the output of a module is to supply data to more than one input of a module, simply create a branch. Click the **left** mouse button once anywhere on the data channel where you want the channel to branch off. Create the connection to the module input as described above.

1.2.2 Rearranging Data Channels or Branches

To Rearrange a Data Channel

First delete the data channel by clicking the channel twice with the **right** mouse button, and then create it again on a different track.

⇨ *Note that the deletion of a data channel segment may delete further segments and/or branches.*

To Rearrange A Junction Point On A Data Channel

Use the **left** mouse button to click once at the junction point that you want to move. The mouse pointer then changes into a branch symbol.

Drag the small box that now represents the junction point to its new position on the data channel.

Establish the new position by clicking the **left** mouse button again. All the data channels affected will be automatically rearranged.

Note that you can only drag the junction point **either vertically or horizontally** along a data channel. If you want to move it around a corner you must first drag it right to the corner, click the **left** mouse button, and then move it in the other direction in a second step.

1.2.3 Deleting Data Channels or Segments

The Quick Way

Use two separate **right** mouse button clicks (not a double-click!) on the data channel to be deleted:

- At the first click, the section that is to be deleted will change its color.
- At the second click it will be deleted.

To cancel the process, click anywhere on the screen but on the same section the second time. The data channel will then resume its previous color.

-Or-

Use the **right** mouse button to double-click at the end of the connection (i.e., the input symbol of the second module).

Confirm the deletion in the dialog box that appears, or choose Cancel.

If you accidentally double-click the beginning of the connection (i.e., the output symbol of the first module), you will be asked to confirm the deletion of that module (instead of the data channel). Click the Cancel button in the dialog box.

To Delete ALL the Input and/or Output Channels of a Module

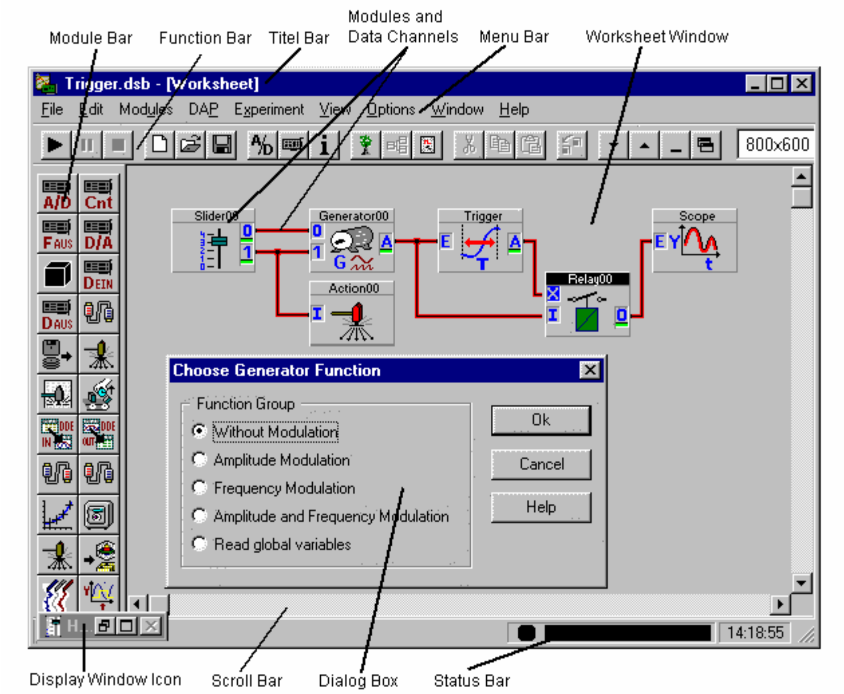
Use the **right** mouse button to double-click on the module symbol. To use your keyboard, select the module first by repeatedly pressing TAB until the module's Title Bar is highlighted, then press DEL.

In the dialog box, click the desired option, then choose OK, or press ENTER on your keyboard.

⇨ *Please note that any confirmed deletion will always be executed in compliance with the other elements of the worksheet. This means that if, for example, you delete a channel section that divides up into branches in its further course, and all those further branches will be deleted too.*

2. The *ServiceLab* Screen

2.1. The Worksheet Window



Work Area: Worksheet Window

The work area is where you create the virtual ***ServiceLab*** experiment setup (the worksheet). It consists of the module symbols and the data channels connecting them.

You can install modules in the worksheet either by choosing them from the Modules menu or by clicking the corresponding icons on the Module Bar.

Data channels must then connect these modules. Every module input must be connected before you can start the worksheet. You do not have to connect every module output.

A worksheet can contain up to 256 modules. The maximum size of a worksheet in pixels is 2000 (vertically) by 2000 (horizontally) regardless of the screen resolution.

The size of the worksheet segment that is actually displayed in the workspace on your screen depends on your display adapter. The area available for a worksheet is much larger than can be displayed on screen at one time.

- You can drag any module to any position on the entire worksheet. Click it once with the left mouse button, and then move it with the mouse button held down. If you touch the window frame, the window will automatically move on across the worksheet in that direction.
- Use the scroll bars to pan horizontally and vertically around the worksheet.
- You can also use the SPACE bar. The cursor will change into a MOVE cursor within the worksheet area. You can now pan the worksheet just by using the mouse. Press the SPACE bar again to switch to normal mode.
- You can drag any module symbol to any location in the worksheet by placing the mouse pointer on it, and pressing and holding down the **left** mouse button while moving the mouse. If you touch the window border while doing this, the worksheet display will scroll until you release the mouse button, placing the module symbol at the new location.

To Display More of Your Worksheet

- Remove the Function Bar and/or the Module Bar from the ***ServiceLab*** window. Choose these options from the View menu, or press ALT, V, F or ALT, V, M.
- To view the complete worksheet in a separate window, choose the Overview option from the View menu, or click the corresponding icon in the Function Bar. However, you cannot edit or change it there. The display is automatically scaled to the size of the worksheet.
- To enlarge the window to its maximum size, click the Maximize button in the upper right-hand corner of the ***ServiceLab*** window, or choose Maximize from the Windows Control menu. The worksheet will fill the entire screen. Other Windows applications, such as the Program Manager, run in the background. After you enlarge the window, the Restore button replaces the Maximize button. Click the Restore button to return the window to its previous size.

To Change the Appearance of the Worksheet

- To change the grid, type of grid, or grid spacing of the ***ServiceLab*** worksheet, choose the Window Setup option from the Options menu.
- To change the colors of the ***ServiceLab*** worksheet, choose the Colors option from the Options menu.
- To change the colors of the ***ServiceLab*** window frame, Menu Bar, etc., choose the Color option from the Windows Control Panel.

- Shortcut menu: you can right-click over the worksheet work area to display a contextual menu. You can change colors, switch to other modes, or display properties for this view.

Worksheet Documentation Area

You can insert information about the worksheet into text boxes that are shown on the background of the worksheet. Use the right mouse button to click on an empty area of the worksheet background and open a context menu that allows you to Edit, Create and Delete text boxes. You can insert up to 256 characters of text, change the font, or modify the background color/style.

Use the left mouse click to move (“catch“ the upper left corner) or resize (“catch“ the lower right corner) the boxes.

Open a New Layout Window

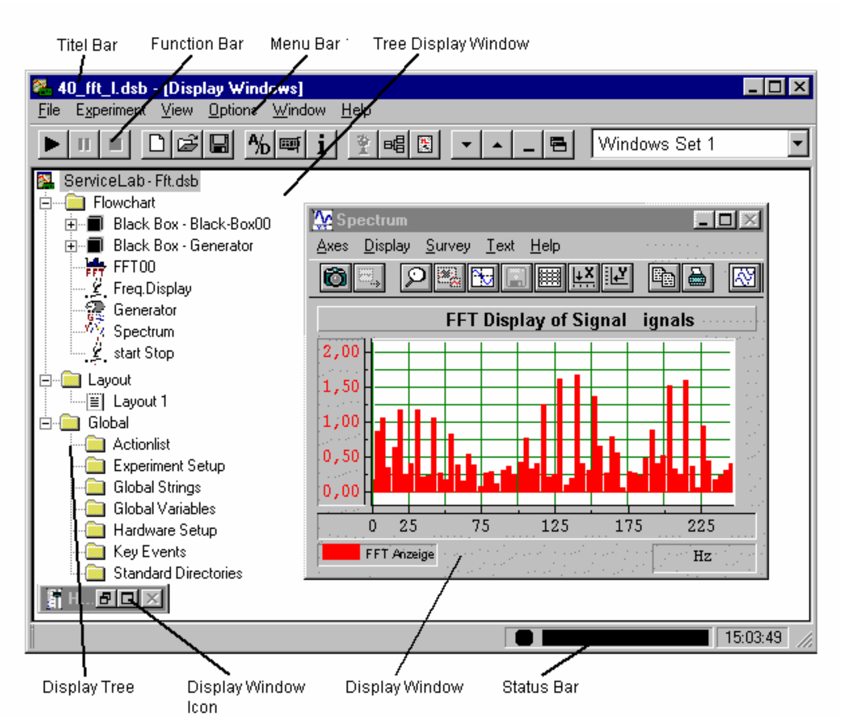
Choose the New Layout Option from the Window menu. An empty window will appear. The Layout Window Function bar and Tool box are now available.

You can place graphical objects and imported bitmaps on this worksheet. You can create links to visualization modules_of the flowchart. Previously opened display windows stay open.

To hide all elements of the worksheet, choose the View: Full Screen option**.** The Layout will be displayed, filling the complete screen. Open display windows are hidden.

Since all control elements are hidden you can only **start** measurement by using the F5 key. To **stop,** use ALT+F5. ESC switches to the window mode of the VITool.

2.2. The Display Tree View

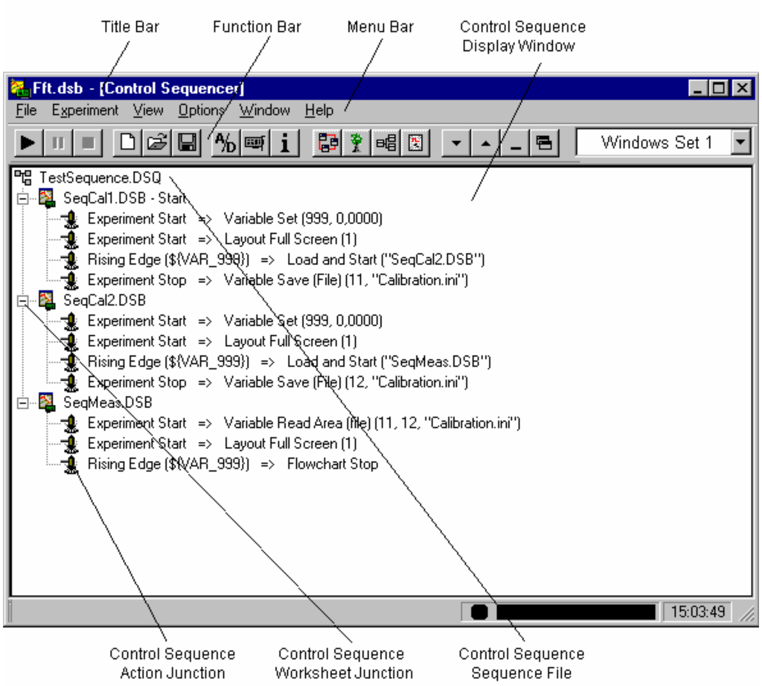


Work Area: Tree View/ Display View

The measurement setup is displayed in a structure similar to the Windows Explorer (32-bit version only). All elements of the worksheet are shown, starting with the layout pages, the modules and black boxes, and finishing with global setup, including global strings and variables. When you click on one of the tree elements, the next branch opens or the appropriate Dialog box opens.

Shortcut menu: you can right-click over the worksheet work area to display a contextual menu. You can change colors, switch to other modes, or display properties for this view.

2.3. The Control Sequencer Window



To control a multi-step application consisting of more than one ***ServiceLab*** worksheets calling each other, ***ServiceLab*** offers a new tool, shown as new display window (analogous to the worksheet, display and VITool windows), called the Control Sequencer Window. The contents of the window is stored in a new type of file, the Control Sequencer file (saved with the suffix ***.DSQ**.)

The window shows a tree display of the control sequence. You can add any number of worksheets into the Control Sequencer File, whose name is shown as root of the tree.

You can also multiple actions for each inserted worksheet to control the flow of the worksheets.

In the Control Sequencer window you can load and save *.DSQ files using the main menu file commands: **New**, Open, **Save** and **Save As…**.

To insert flowcharts or actions you need to use the pop-up context menu that appears when you right mouse click on one of the junction points on the screen. Depending on the junction (flowchart or action) the pop-up menu offers several commands to add, delete or to edit the object.

⇨ *The Sequence file is a binary file type. You cannot edit it with ASCII Editor programs such as Notepad.*

Work Area: Control Sequencer View

The window shows a tree display of the control sequence. You can add any number of worksheets into the Control Sequencer File. The Control Sequencer filename is shown as the root of the tree.

Also you can define several actions for each inserted worksheet to control the flow of the worksheets.

In the Control Sequencer window you can load and save *.DSQ files using the main menu file commands: New, Open, Save and Save As….

To insert worksheets, simply right mouse click on the root symbol to open the context menu. The new flowchart command opens the standard explorer window dialog box to select any flowchart. If there is a flowchart already inserted, the context menu offers additional items to handle flowcharts and actions (insert, delete…).

Control Sequencer Flowchart Junction

You can add any number of worksheets into the Control Sequencer File. The inserted flowchart is shown as new flowchart junction.

Double-click on the junction or select the Comment Flowchart context menu command to add or edit a description of the junction.

Control Sequencer Action Junction

You can add any number of actions to each flowchart in the Control Sequencer File. The inserted actions are shown as new branch of a flowchart junction.

Each action will be processed if the defined condition is fulfilled. The conditions depend on the settings of global variables or strings or are global events such as Start/Stop of measurement. All global actions are allowed.

Double-click on the junction or use the Edit Action context menu command to modify the action

Sequencer Action Dialog

You can edit the actions assigned to each flowchart in the control sequence file. The Action selection field offers all global actions. The dialog box may change depending on the action you have selected. Functions that control changing values are always assigned to global Variables (Event Parameter: Variable No setting.).

Function	The action is initiated...
Rising Edge:	When the variable changes from TTL Low (value 0) to TTL High (value 5).
Falling Edge:	When the variable changes from TTL High (5) to TTL Low (0).

Threshold Overflow:	When the variable rises above the specified threshold value.
Threshold Underflow:	When the variable falls below the specified threshold value.
TTL High Level:	When the variable is TTL High (5).
TTL Low Level:	When the variable is TTL Low (0).
Input larger than Threshol	As long as the variable value is larger than the threshold value.
Input smaller than Thresho	As long as the variable value is smaller than the threshold value.
Start/Stop of Measuremen	At the beginning and/or at the end of the measurement.
Global String has changed	If the named global string has changed during measurement.
Input value has cha 0.001%):	If the variable value has changed
Value is reached (+/- 0.00	If the variable reaches the defined value.
Always:	The action is constantly initiated.
Never:	The action is never initiated (NOP).

⇨ *Global variables and strings are always saved with the corresponding flowchart. In exactly the same way, the Global Variables and Strings used in the event-driven actions in the sequence window are stored in the worksheet file of the corresponding flowchart where the action is defined in the sequence. If the variables or strings are to be used in other flowcharts you must save them using the actions Write String/Variable to INI file and Read String/Variable from INI file to save and reload the values separately.*

You will find more information about Event driven Actions parameters in the Action Module description.

Control Sequencer File

The Control Sequencer file stores all settings made in the tree. You can add any number of worksheets into the Control Sequencer File.

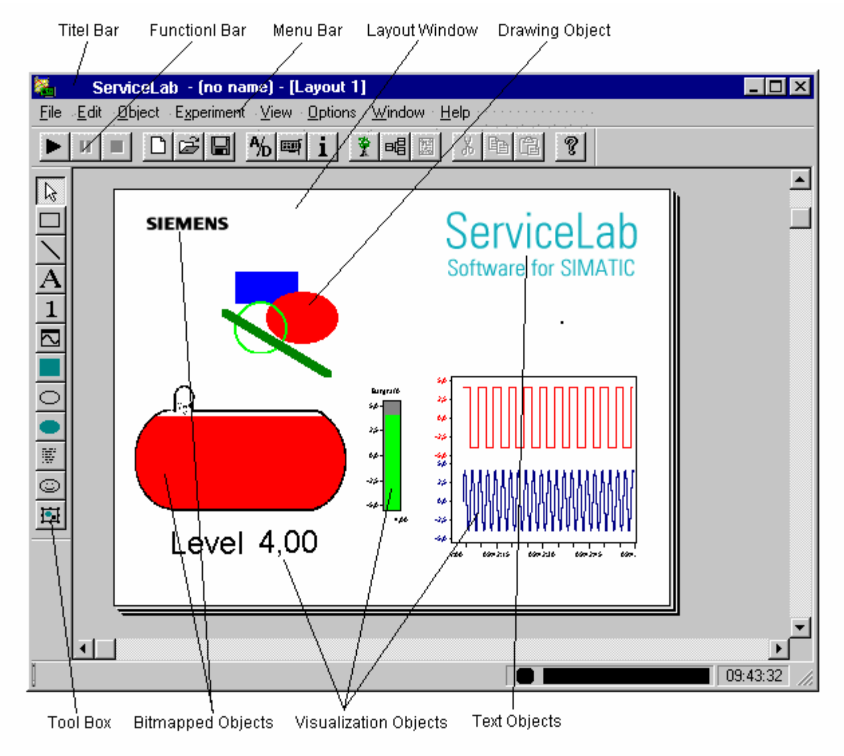
You can define several actions for each inserted worksheet to control the worksheet flow.

The Control Sequencer files (*.DSQ) can be loaded and saved using the main menu file commands: New, Open, Save and Save As….

Sequencer Comment Dialog

This dialog is used to add an additional description to each flowchart in the sequence file. The description is linked in the Control Sequencer mode to the name of the corresponding flowchart.

2.4. The Layout Window



Work Area: Layout Window

The ***ServiceLab*** Visualization tool (**VITool)** allows you to connect a bitmapped graphical object with the active Elements of the Layout Window, so you can generate a practical on-line display of relevant data values. You can use technical worksheets or pictures as background and place the Display Windows of ***ServiceLab*** on the screen. Status Lamps, for example, are symbols of running engines, Digital Meters show rpm, and Bar Graphs can look like thermometers - all to give you quick information about the temperature of a vessel or the status of other parts of the plant.

You can create up to 200 Layout Windows for each worksheet window using the main menu option window. The size of the working area can be specified in one of several DIN formats or adapted to the screen size. The zoom function allows you to scale parts of the screen for better handling.

Full size mode allows you to hide all functional elements such as the Function Bar, Title Bar, etc. This mode is very useful for Online Presentation where you want to display only the custom designed display, not the program elements.

Work Area Layout Window

The work area is where you create a Layout belonging to the ***ServiceLab*** experiment setup (the Worksheet). The size of the worksheet segment that is actually displayed on your screen varies depending on your display adapter. In any case, the area available for a worksheet is much larger than can be displayed on screen at a time. You can use the scroll bars to pan horizontally and vertically around in the worksheet. You can also use the SPACE bar. The cursor will change into a MOVE cursor within the worksheet area. You can now pan the layout just by using the mouse. Press the SPACE bar again to switch to normal mode.

You can create objects in the work area either by choosing them from the Object menu or by clicking the corresponding icons on the Tool Box. These objects are placed onto the worksheet by drawing a frame with the mouse. Linked objects are connected to Display Modules of the Worksheet. You can scale or move objects on the worksheets

Shortcut menu: you can right-click over the worksheet work area to display a contextual menu. You can select objects to add to your layout, switch to other modes, or display properties for this view or the layout page.

New Layout

Window Menu Command: New Layout

Use this command to create a new Layout window. Up to 200 Layout sheets can be created with 512 Layout objects. The name of worksheet and the first nine Layout windows are displayed below the menu commands. If there are more than ten windows you can use the more command to see them.

Properties of the Layout Page

Double-click with the left mouse button on an empty part of the Layout Window, or, use the Properties Object Menu Command to view the Properties Dialog Box.

Tool Box

When a Layout window (optional) is active, the Tool Box will also be shown. Select a tool by clicking on the Symbols.

The following tools are available:

- Selection Tool
- Line
- Rectangle (filled or not filled)

- Ellipse (filled or not filled),
- Bitmap,
- Text Line,
- Text Block,
- Grid
- Linked Text
- Linked Graph

Creating a new Layout Object

Select an object type using the menu or the ToolBox. Draw a frame of the desired size. You must create a frame when using a Text Object. The object will be inserted into the frame. To set the object's properties double click with the left mouse button on the object to open the Properties Dialog Box.

The size and position of objects may be changed using the mouse or by using the keyboard. To move the object just use the arrow keys, to resize the objects use CTRL+ arrow key. The degree of movement and scaling depends on the settings in VITool page setup.

Types of Objects:

- Drawing Elements: You can create Lines, filled and unfilled Rectangles or Ellipses. You can import Bitmaps.
- Visualization**:** You can create Linked Elements that import strings (Linked Text) or Graphs (Linked Graph) into your Layout Window.
- Text Elements: Text frames with Line or Block Text can also be integrated into your Layout. The text itself can be edited in the Properties dialog box

Working with Layout Objects

A single mouse click will select the object. Now you can resize or move it. Backspace will delete the selected object.

A single mouse click with the right mouse button on an object opens a pop up menu. (You cannot change objects while the measurement is running.) Double mouse click on the object to open the Properties dialog box for that object.

Creating an Object

Select an object type using the menu or the ToolBox. Draw a frame of the desired size. You must create a frame for a Text Object. The object will be inserted into the frame. Open the Properties dialog box by double clicking the **left** mouse button on the object.

Passive Elements

In the ***ServiceLab*** Layout Window (optional) there are some objects that are created on the worksheet although they don't have a direct connection to modules on the worksheet. These passive elements are simple graphical objects such as lines, circles, ellipses (filled or unfilled), or text. Position, size and color are freely selectable for each element. You can modify other properties for each element, too. Passive elements are useful to create an attractive layout page design. Block text with scaleable font size is useful to display information about the layout (for example, the measurement parameters).

You can also specify the text line object: Using field placeholders, you can insert the current time, date or other system information.

Active Elements

Another group of objects shows the unique features of the **VITool (optional)**. These active connected objects create a direct link with modules on the ***ServiceLab*** worksheet. Information that is displayed in the display window of the visualization module can be integrated into the Layout Window and can be dynamically updated as the data changes. The **VITool (optional)** is a perfect instrument to create an online data acquisition and visualization setup that reflects your ideas and creativity. Available active elements are linked with graphical and text objects.

Linked graphical objects import graphical information from the display windows of visualization modules into a Layout Window. You can show the curves of Y/t, X/Y or Recorder module as well as the display of Analog, Digital Meter or Lamp and Bar Graph or you can display an alert message from the message module.

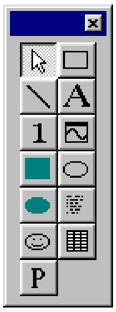
A special feature links an object to the Switch module: You can show the state of the switch and operate the module from the Layout Window. This allows you to interact with the measurement when the Layout Window is in full screen mode.

Graphics

The ***ServiceLab*** **VITool** allows you to import bitmapped graphics objects and use them as background in the Layout Window. You can use plant flowcharts and other pictures as background in the Layout Window and you can place other passive or active elements over them. For example, status displays placed over machines show activated engines, a Digital Meter shows their rotational speed, Bar Graphs shaped as thermometers quickly inform you of the temperature of several parts of a plant. You can even insert your own logo into the layout. Only the reference address of the picture files (*.BMP and *.WMF format only) are saved with the worksheet or with the layout file. The original picture file must be separately saved in the correct directory to be displayed in the Layout Window.

You cannot use pictures and drawings created by CAD programs. You must first convert the files into .BMP or .WMF format using appropriate conversion software.

2.5. VITool Toolbox

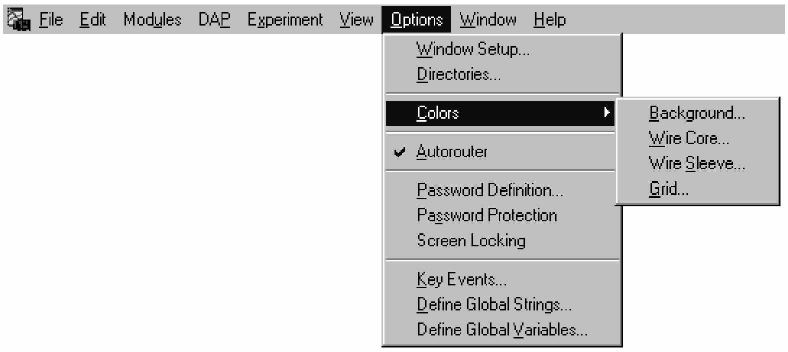


The Layout Window Toolbox allows you to quickly select a Layout Window Drawing Object.

2.6. Title Bar

The Title Bar is the upper border of the ***ServiceLab*** window and shows the name of the application (***ServiceLab***) and the file name of the current worksheet. If the current worksheet has not yet been saved, “Untitled” appears as a placeholder.

2.7. Menu Bar



Below the Title Bar, the Menu Bar lists the Main Menu Options. Each menu contains a list of commands or actions. You can open each of these lists by clicking the Main Menu Option on the Menu Bar with the **left** mouse button, or by pressing the ALT key and then typing the letter that is underlined in the Main Menu Option.

In the picture above, you see the list of Options menu commands.

You can then choose an option from that list by clicking it, or by typing the letter that is underlined in the menu item without pressing the ALT key, or by using the arrow keys on your keyboard and pressing ENTER. The display field in the left half of the Status Bar will often contain information describing the current menu item.

In the picture, the Wire Sleeve option from the Colors submenu is selected (highlighted). Click it, or press the ENTER key, to carry out that command.

The following Windows menu conventions provide additional information about the menu items.

- An ellipsis (...) following a command indicates that a dialog box appears when you choose that command. There, further options must be selected before the command can actually be carried out. For example:

  Output Setup... (Experiment menu)

- A triangle (▶) next to a command indicates that a cascading menu appears when you choose that command. That submenu contains further commands. For Example:

  Module Bar ▶ (Edit menu)

- A check mark (✓) next to a command means that the command is already in effect. After selecting that command again, the command is no longer in effect, and the check mark disappears. For example:

  ✓ Auto Start (Experiment menu)

- Dimmed commands cannot be used at the current time. For example, another command must be chosen first to enable that command. For example:

  Stop (Experiment menu)

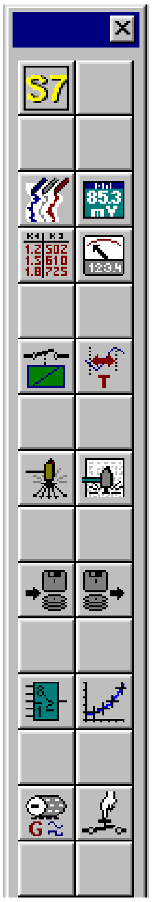
  Stop is only available after Start is chosen, and vice versa.

- A key combination next to a command is a shortcut for the command. To use your keyboard instead of your mouse, the key combination has the same effect as clicking, or choosing, the command from the menu list. For example:

  Pause CTRL+F6 (Experiment menu)

*The icons on the Module Bar and on the Function Bar also represent menu functions. Clicking these icons with the **left** mouse button is the easiest and quickest way of choosing a menu command.*

2.8. Module Bar



The Module Bar, at the left of the ***ServiceLab*** window, displays a selection of frequently required modules in icon form. The size of the Module Bar depends on the screen resolution of the computer's display.

Use the **left** mouse button to click on the icon that symbolizes the module you want to add to your worksheet.

There are only a limited number of spaces on the Module Bar; therefore not every available module can be displayed on the Module Bar. You can customize the Module Bar to display only the modules that are needed most frequently.

Module Type Display

The name of the module the mouse pointer is pointing at is displayed in a small window above the module icons.

Module Bar Configuration

You can determine which modules are displayed as icons on the Module Bar.

Click on a square in the Module Bar with the **right** mouse button to assign any of the modules available in ***ServiceLab*** to that square. A dialog box appears presenting the complete list of modules including their Module Bar icons.

- Scroll through the list using the scroll bar or the arrow keys on your keyboard.
- To quickly select a module in this list, type the first letter of its name to move to the first matching module. Type the letter again to move to the next module that starts with that letter.
- Click the Help button to obtain information on the selected module.
- Choose OK, or press ENTER, to install the selected module on the Module Bar. The Module Bar will now display the new icon.

Saving a Module Bar Configuration

You can customize several Module Bars for individual experiments.

- All of the Module Bar settings are automatically saved together with information about the window size and position when you exit the program. When you start ***ServiceLab*** the next time, you will find the same work environment as before.
- In addition the settings are saved with the worksheet file when you choose the Save or Save As... commands from the File menu.

- You can individually save your customized Module Bars to files and open them when you work with similar tasks or you can open the Default Module Bar provided by ***ServiceLab***.

  Use the Module Bar command in the Edit menu:

  New — provides a blank Module Bar to be configured individually.

  Open... — opens a saved Module Bar configuration onto the ***ServiceLab*** screen.

  Save As... — saves the current Module Bar configuration to a file under a name of your choice.

  Default — opens the default Module Bar configuration onto the ***ServiceLab*** screen.

  Basic — Displays a limited number of modules, suitable for beginners

  Intermediate — Displays more modules, appropriate for experienced users

  Advanced — Displays modules appropriate for “power users.”

  For details about these menu functions refer to Chapter 4 of this manual.

Removing the Module Bar

To enlarge the display area for your worksheet, you can remove the Module Bar from the screen. The visible worksheet then extends to the left border of the ***ServiceLab*** window.

Use the Module Bar command from the View menu to hide and to redisplay the Module Bar. A check mark (✓) indicates that the Module Bar is displayed.

After you have hidden the Module Bar, you can still install modules by using Module menu commands. To install a Signal Generator module, for example, select Control from the Module menu, then choose Generator, or press the `ALT`, `M`, `C`, `and G` keys.

2.9. Function Bar

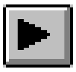
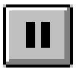
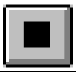
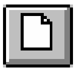
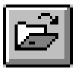
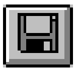
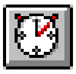
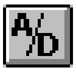
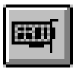
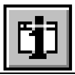
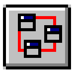
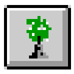
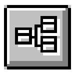
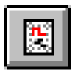
The Function Bar**,** below the Main Menu Bar of the ***ServiceLab*** window, displays a selection of icons that provide easy access to menu functions often used during experiments. Use the **left** mouse button to click on the icon that represents the desired command.

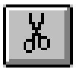
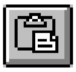
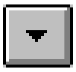
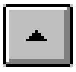
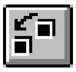
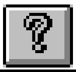
When the mouse pointer is pointing at a Function Bar icon, a tag with the name of that function will appear. (You will find QuickInfo in all of the module windows that provide a Function Bar.)

Function Bar Configuration

The configuration of the Function Bar is fixed. You cannot change it by removing or adding any icons.

The following table contains a list of the icons included and the menu commands they represent. For further details about the menu functions themselves refer to Chapter 4 of this manual.

Icon	Function	Command	Menu	Shortcut
	Start experiment	Start	Experiment	F5
	Pause experiment (toggle)	✓Pause	Experiment	CTRL+F6
	Stop experiment	Stop	Experiment	CTRL+F5
	Clear worksheet to create a new worksheet	New	File	
	Open worksheet file	Open…	File	
	Save worksheet to file	Save	File	
	Set up different time bases	Time Base	Experiment	
	Set general experiment parameters (dialog box)	Experiment Setup	Experiment	
	Set hardware-specific parameters (dialog box)	Hardware Setup	Experiment	
	Open File Info dialog box	File Info…	File	
	Switch to Control Sequencer mode	Control Sequencer	Windows	
	Switch to Display Window mode	Display Windows	Windows	F2
	Switch to Worksheet mode	Worksheet	Windows	F3
	Switch to VITool Layout Window mode	Layout	Windows	F4

Icon	Function	Command	Menu	Shortcut
	Cut the marked object and copy it to the Windows clipboard	Cut	Edit	
	Copies selected Worksheet part or Layout object to clipboard	Copy	Edit	
	Inserts contents of clipboard into Worksheet or Layout Window	Paste	Edit	
	Deactivate all the display windows (reduce to icons or hide, depending on setting in Options/Window Setup)	Minimize/Hide Display Windows	View	
	Activate all the display windows, depending on setting in Options/Window Setup	Normalize/Show Display Windows	View	
	Leave the Black Box, return to preceding worksheet level (or to the main chart). To enter a Black Box, double-click its module in the worksheet.	To Preceding Black Box Level or Back to Main Chart	Edit	
(list)	Re-arrange display windows into one of the ways you have saved	Select Window Arrangement	View	
	Display ***ServiceLab*** Online Help options	Help	Help	

Removing the Function Bar

To enlarge the display area for your worksheet, you can remove the Function Bar from the screen. The visible worksheet then extends to the Menu Bar of the ***ServiceLab*** window.

The Function Bar command from the View menu enables you to hide and to redisplay the Function Bar. A check mark (✓) indicates that the Function Bar is displayed.

After you have removed the Function Bar, you can still use any function by selecting it from the menu. To start an experiment, for example, choose Start from the Experiment menu, or press the ALT, X, S keys, or press F5.

2.10. Status Bar

The Status Bar at the bottom of the ***ServiceLab*** window provides the following information:

- On the left of the display you will find an explanation of the menu function you have selected on the Menu Bar.
- The status bar on the right displays the progress of operations, for example, of the Autorouter function arranging data channels, or, during experiments, the driver buffer status.

  If the bar turns red, this indicates that the acquisition rate is too fast to collect data continuously. Left of the driver buffer indicator there is a small indicator for lost samples. Many drivers acquire data using interrupts. Some boards allow ***ServiceLab*** to check whether the program has processed all interrupts. A yellow flashing light indicates that some interrupts have been missed. For more detailed information see the hardware help.
- The current time is displayed on the far right.

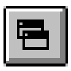
2.11. Display Windows

Display Windows of the Display modules show data samples in various graphical ways. You can choose X/Y, Y/t Chart, Chart Recorder, Bar Graph, Digital or Analog Meter. You can customize the appearance of Display Windows in many ways.

Hiding and Showing Display Windows

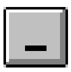
The modules from the Display module group consist of two parts: the module symbol in the worksheet, and a display window where the incoming data is visualized. When a display module is inserted into the worksheet, the display window initially appears minimized.

You can restore each of the display windows contained in your worksheet individually by double-clicking its icon at the bottom of the computer screen, or by choosing Select Windows/Restore from the View Menu.



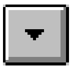
You can restore all the minimized display windows contained in your worksheet simultaneously by choosing All Windows/Restore from the View menu, or by clicking this Function Bar icon.

You can minimize each of the display windows individually by clicking its Minimize button (in the upper right-hand corner of the display window).



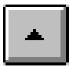
You can minimize all the display windows contained in your worksheet simultaneously by choosing All Windows/Minimize from the View menu, or by clicking this Function Bar icon.

You can hide a display window without minimizing it. Use the View menu command Select Windows/Make Invisible. You can hide minimized display windows to make your work area easier to read.



You can hide all display windows, including minimized windows, by clicking on the Hide button or choosing All Windows/Make Invisible from the View menu.

You can show (un-hide) a hidden display window by choosing the Select Windows/Make Visible from the View menu.



You can show (un-hide) all hidden display windows by clicking on this Function Bar icon, or by choosing the all Windows/Make Visible command from the View menu.

Window Arrangement

This field shows the number and name of the current Window Arrangement. ***ServiceLab*** allows you to save up to eight different Display Configurations to be used by the experiment: Switch to another arrangement by choosing the name displayed in the list. The Window Arrangement can also be switched using the Action module.

While observing an experiment, with data being displayed on several instruments, you may find it useful to save certain arrangements of these display windows (i.e., their sizes and positions on the screen). You can then easily restore any of these arrangements when it seems most suitable, and you can even switch between various window setups to compare different display modes.

For these purposes, ***ServiceLab*** provides the following menu commands:

Save Window Arrangement

Select Window Arrangement

Delete current Window Arrangement

3. Module Groups Overview

ServiceLab module functions are divided into ten Module Groups**,** each containing modules that perform related functions.

The Module menu provides all the available module groups. Choose a module group from the Module menu to open a submenu with the list of the modules that belong to that group. You can select any of the modules listed by clicking on it. It is then placed on the worksheet as a module symbol.

- The Input/Output and the Files modules provide data input and output functions, including data archiving using the new Backup module.
- The Trigger Functions and the Control modules perform control tasks.
- The Mathematics, the Statistics, the Signal Analysis and the Data Reduction modules offer a large number of analysis, evaluation and calculation operations.
- The Display modules provide several ways of displaying data.
- The Black Box module allows you to store complete worksheet segments in one module as ready-to-use units.

Input/Output Module Group

This group provides all the function modules necessary to communicate with SIMATIC and the data acquisition hardware, external devices and other programs. The modules Analog Input, Analog Output, Digital Input, Digital Output and Counter Input represent different functions of the data acquisition hardware, while DDE Input and Output implements DDE communication with other Windows applications. SIMATIC S7, Serial Input and Output and the IEEE488 Interface modules represent the interfaces to the corresponding devices.

Files Module Group

This module group provides file reading and writing functions. It consists of Read Data, Write Data, Backup and ***FlexPro*** modules.

Trigger Functions Module Group

This module group contains the Start/Stop Trigger and the Pre/Post Trigger modules, which are used to control data flow in the worksheet depending on the acquired signal. The Combi Trigger allows you to detect a wide combination of signal changes. The Relay module is used in conjunction with the trigger modules to control the flow of data.

Control Module Group

This module group contains two different types of modules. There are four signal generating modules: the Generator can generate periodic or random signals; the Switch allows manual input of TTL low and high levels; the Slider is used to manually define an analog signal; and the TTL Pulse Generator will generate a

pulse of specific duration. The PID Control, Stop, Latch, and Time Delay modules may be used to control data flow within the worksheet.

Mathematics Module Group

This module group provides basic mathematical functions including Arithmetic and Trigonometry, Logic Operations, Linear Scaling, Thermocouple Linearization, Interpolation, Differentiation/Integration and the general purpose Formula Interpreter.

Statistics Module Group

This module group provides several statistical calculations including standard deviation, min/max, mean values, and variance in the module Statistical Values. It also contains function modules for Histogram calculation, Counting and the calculation of Regression.

Signal Analysis Module Group (optional)

This module group contains several modules for signal analysis applications. It implements digital (IIR) Filters of different types, the calculation of FFTs, frequency spectrum, amplitude and phase spectrum, Correlation functions and cepstrum. Another module provides a number of different Window functions. Polar/Cartesian coordinate transformation is now part of this module group.

Data Reduction Module Group

This module group contains different algorithms for data reduction including Averaging and Block Average, the selection of samples and blocks, and modules that allow you to combine and separate signals from different channels, including Time Slice, Merge/Expand and Cut Block.

Display Module Group

This module group contains all the display modules. It includes the scope display (Y/t Chart), Chart Recorder, X/Y Chart, Analog and Digital Meters, Bar Graph, and List modules.

Network Module Group (optional)

The high-speed, TCP/IP network capable modules are available in this optional module group.

Special Module Group

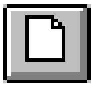
This module group contains Black Box modules to be “filled” with worksheet segments and with Export/Import modules which establish connections for data transfer between the main worksheet and the Black Box worksheet embedded in it. It also provides the Black Boxes that were saved to disk. Additionally, it includes modules that provide special functions, including the Action, Message and Time Base modules, as well as the Signal Adaptation module.

Chapter 4: Main Menu

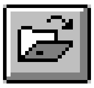
1. Worksheet Window Menu

1.1. File Menu

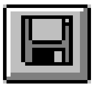
The commands of the File menu enable you to save, open and print worksheets, to manage your worksheet files, and to exit the program. Some of these functions can also be chosen by clicking on the corresponding icons on the Function Bar. The ellipsis (...) following a menu command indicates that a dialog box or sub-menu will appear when the command is selected.



New

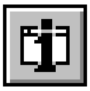


Open...



Save

Save As...



File Info...

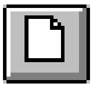
Print...

Printer Setup...

Page Format...

Exit

1.1.1 New



***Choose the** New **command from the** File **menu, or click this Function Bar icon to create a new worksheet**.*

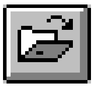
This command will open a new worksheet. If you have a worksheet open and have not saved it, you will be asked to:

- save that worksheet before beginning work on the new one,
- or to reject those changes,

- or to recall the New command.

After creating the new worksheet you can save it to a file by selecting the Save or the Save As... command for the File menu. You can also click on the Save icon in the Function Bar to save the current file.

1.1.2 Open...



Choose the Open command from the File menu, or click this Function Bar icon to open a previously saved worksheet.

If you have a worksheet open and have not saved it, you will be asked to save that worksheet before beginning work on the new one.

After choosing the Open command you can select from a list of files using standard Windows dialog boxes. The default file extension for ***ServiceLab*** worksheet files is .DSB.

You can ...

- Open one of the files from the list directly by double-clicking the file name,
- Select a different directory by double-clicking the directory name,
- Select a different file format for the file display, or
- Select a different drive.

To use your keyboard, press the TAB or the SHIFT+TAB keys to move from one field to another; select items from the lists by pressing ↑, ↓, SPACE and the ENTER key.

In the File Name box you can define the filter for the file list. The default setting for the filter (*.DSB) will create a list of ***ServiceLab*** worksheet files, which usually have the extension .DSB. ***ServiceLab*** can also load files with the extension *.**DSA**. This format is used to exchange worksheet files between the 16 and 32 bit ***ServiceLab*** versions. These files may have also other extensions such as *.txt, but to be interpreted correctly, the contents MUST follow the conventions of the ***ServiceLab*** ASCII file type.

You can type a different extension, or use wildcards (like *.*), to get lists of different groups of files. For example, you may do this if you have saved ***ServiceLab*** worksheets with extensions other than .DSB.

⇨ ***ServiceLab*** *can only open files in its own .DSB format, no matter what extension the files have.*

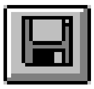
⇨ *If Password Protection is active, you will first be asked to enter the password unless you have already entered it. Without the correct password, the file will not be opened.*

When you save a worksheet, the current Module Bar configuration is saved with it. When you open a worksheet file, its Module Bar configuration will replace the current one on your screen. If you prefer to retain the current configuration, disable the Replace Module Bar option in the Options menu.

*You can specify a standard directory for **ServiceLab** worksheet files in the Options menu.*

To create a new worksheet, select the New command from the File menu, or click the New icon in the Function Bar.

1.1.3 Save



Choose the Save command from the File menu, or click this Function Bar icon to save a worksheet.

If you have created a worksheet without saving it to a file, the Save command will act like Save As... If this were a previously saved worksheet, the existing file will be replaced without further messages.

The following settings *are* saved with the worksheet:

- The current Module Bar configuration
- All the entries in the File Info dialog box
- All the entries in the Page Format dialog box
- The settings for Display Window Arrangement
- Text strings, with locations of where they were placed in the display window

The following settings are *not* saved with the worksheet.

- The settings for the Start/Stop at Time functions (Experiment menu)
- The settings for the Auto Start function (Experiment menu)
- The settings for the display of the Module Bar, the Function Bar and the Animation function (View menu)
- The Options Menu settings for the Window Setup, Colors, the Autorouter functions

*You can specify a standard directory for **ServiceLab** worksheet files (Options menu command).*

To save the worksheet with a new file name, select the Save As... command from the File menu.

If Password Protection is active (Options menu, see page 4-49), the worksheet will be protected using the specified password. If a password has not yet been defined, you will be asked to specify it when the worksheet is saved.

To save the worksheet with a different file name, select the Save As... command from the File menu.

1.1.4 Save As...

*Choose the **Save As** command from the **File** menu to save a worksheet under a new file name, in a different directory, or on a different drive.*

See the previous section for a list of the settings and parameters that will be saved together with the worksheet.

After you have chosen the Save As... command from the File menu you can select the file name, the directory and the disk drive where the file is to be stored.

- Type the file name in the File Name box. Note that the file name must be chosen in accordance with MS-DOS conventions.
- If you do not type an extension, ***ServiceLab*** will automatically add the standard extension (.DSB). ***ServiceLab*** always saves worksheet files in its own format, even if you select an extension other than .DSB.
- You can...
  - … Select one of the file names in the list by double-clicking the file name. The file that was originally saved under that name will be replaced with the new worksheet. A warning message will first appear, asking you to either confirm the procedure or to cancel it.
  - … Select a different directory by double-clicking the directory name.
  - … Select a different drive for the new file.
  - … In the List Files of Type box you can select the type of files (defined by their extension) to be listed.

To use your keyboard, press the `TAB` or the `SHIFT+TAB` keys to move from one field to another; select items from the lists by pressing ↑, ↓, `SPACE` and the `ENTER` key.

*You can specify a standard directory for **ServiceLab** worksheet files (Options menu command).*

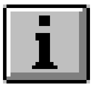
To save the worksheet under its current file name, use the Save command from the File menu.

To quickly save the current file, click the Save icon on the Function Bar.

If password protection is active (from the Options menu), the worksheet will be protected by a specified password. If the password has not yet been defined, you will be asked to specify it when the worksheet is saved.

***ServiceLab** always saves worksheet files in its own format, even if you select an extension other than `.DSB`.*

1.1.5 File Info...



***Choose the** File Info **command from the** File **menu, or click this Function Bar icon to display, enter, or modify information about the open worksheet**.*

ServiceLab will automatically provide the following fields. The user cannot modify these fields.

Field	Information
Worksheet	The file name of the current worksheet
Created	The date and time the worksheet was created
Modified	The date and time the worksheet was last saved to file

You can add the following information:

Field	Information	Max. Number of Characters
Author	Your name	50
Company	Your company	50
Department	Your department	50
Title	A descriptive worksheet title	80
Info Text	Additional informative text	4000

To begin a new line in the Worksheet Info Text field, press CTRL+ENTER.

To move from one field to the other, either use your mouse, or press the TAB or SHIFT+TAB keys.

Click on the Clipboard button to copy all of the information to the Windows Clipboard.

*All the File Info entries will be saved with the worksheet when you choose Save or Save as... from the File menu. The Author, Company, and Department information is also stored in the **SERVICELAB.INI** file.*

When you print a worksheet or the display of a module from the Display module group, you can include the information about Author, Company, Department, Title, and Worksheet file name from the File Info dialog box. Choose Page Format from the File menu to select the information you wish to include in the printing.

1.1.6 Print...

Choose the Print command from the File menu.

Choose Page Format from the File menu to select additional worksheet information you wish to include on the printout, and to specify the page layout and page frames.

Choose Printer Setup from the File menu to select paper size and paper source, orientation, printer resolution, and other specific settings for your active printer model.

⇨ ***ServiceLab** only prints to the default Windows printer. To use a different printer connected to your system, or to install and configure a new printer, choose the* Printers *option in the Windows Control Panel. Refer to your Windows documentation for further information.*

1.1.7 Printer Setup...

*Choose the **Printer Setup** command from the **File** menu to select paper size and paper source, orientation, printer resolution, and other specific settings for your active printer model.*

These settings are also valid when printing Layout Windows. You should pay attention to the settings of the Layout Window, especially the page orientation.

The options vary, depending on the printer you are using.

- Change the specifications as needed.
- To set options specific to your printer driver, choose the Options button, set the options as needed, and then choose the OK button.
- For information about the printer-driver options, choose the Help button or press F1 while using the dialog box.
- Choose the OK button.

Some Printer-Drivers allow you to choose user defined page formats. If the minimum useable size (depending on the printer type) is under run, the printer will not print. So if your printer will not work, check the settings in printer dialog box and enlarge the size of page or use one of the preset page formats (e.g. A4, letter...)

1.1.8 Page Format...

*Choose the **Page Format** command from the **File** menu to format printing. The settings affect the following print commands:*

Printout of...	Source module	Print command from module menu
Worksheet	(Work area)	File (Main Menu Option)
Y/t chart	Y/t Chart	Display
X/Y chart	X/Y Chart	Display
Diagram	Chart Recorder	Display
List of values	List Display	Edit

You can select additional information to include in the printout, and you can specify the page layout and page frames.

The upper part of the dialog box mirrors the basic layout of the printed page.

View port

The actual information or display that is to be printed is indicated in the center of this area. Depending on the source module from which the printing will be activated, the worksheet, the graphic display, or the list of values will be positioned here.

The final size of this area on the printed page is defined by the paper size, minus the selected paper frames, and minus the space required for any additional information. The actual display will occupy the entire page if you select no additional information. The more information you select, the smaller the space remaining for the actual display.

Additional Information

- In the text box and the check boxes above the View port area you can select the information that will be printed above the display at the top of the page.
- In the text box and the check boxes below the View port area you can select the information that will be printed below the display at the bottom of the page.

You can enter one text line of up to 80 characters in the text boxes.

Select information already entered and saved elsewhere.

- The Experiment Title, Author, Company, and Department will be printed as entered in the corresponding text boxes of the File Info dialog box from the File menu (see page 4-5). Commas will separate the printed information about Author, Company, and Department.
- The date and the time of the printing will be printed at the position indicated by the Date/Time check box.
- The Worksheet Name to be printed is the file name of the current worksheet.
- When you select Description the worksheet file name will be printed when you print the worksheet itself. The Worksheet Info Text from the File Info dialog box will not be included in the printout.

  When you wish to print a graphic display or a list of values, the module description printed will be the Description text box of the source module's configuration dialog box. This dialog box appears when you double-click that module symbol on the worksheet.

Page Frame

Set the margins for the printed page. These are the distances between the paper edge and the printed area of the paper. The measurement system is *always centi-*

meters. The default settings are 2.54 cm (one inch) or the values last saved with a worksheet.

Printer...

Click this button to select paper size, source, orientation, printer resolution, and other specific settings for your active printer model. This function is the same as the Printer Setup command from the File menu.

All the Page Format entries will be saved with the worksheet when you choose Save or Save as... from the File menu.

1.1.9 Exit

*Choose the **Exit** command from the **File** menu to close **ServiceLab**.*

*You can also exit **ServiceLab** by double-clicking the system control button in the upper left hand corner of the **ServiceLab** window, or by pressing* ALT-F4.

If you have not saved or have changed the worksheet in the work area, you will be asked whether you want to save the changes or not, or cancel the exit request.

The following settings are saved when you close ***ServiceLab**:*

- Size and position of the ***ServiceLab*** window on your screen
- The Module Bar configuration
- The information about Author, Company, and Department from the File Info dialog box
- The Autostart option (Experiment menu)
- The Animation option (View menu)
- The display settings of the Module Bar and the Function Bar
- The Window Setup (Options menu)
- The Color settings (Options menu)
- The Autorouter option (Options menu)
- The Password Protection option (Options menu)

If there is a worksheet on the screen which you have changed since you last saved it, you will be asked to either save that worksheet now before exiting ***ServiceLab***, or to reject those changes or to recall the Exit command (Cancel).

You can also exit ***ServiceLab*** by double-clicking the system control button in the upper left hand corner of the ***ServiceLab*** window, or by pressing ALT+F4.

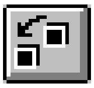
1.1.10 Recently Used File List

The worksheets displayed as numbers 1 to 5 in the File menu contain the five worksheets worked on last. The list is automatically rebuilt when loading any worksheet and is stored when the program is closed.

1.2. Edit Menu

The commands of this menu allow you to copy the ***ServiceLab*** worksheet displayed on the screen to the Windows Clipboard and to configure the Module Bar according to your specific requirements. It also provides the functions necessary to organize Black Box files.

Worksheet to Clipboard



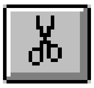
Black Box Module
- **Save As**...
- **Load**...
- **Black Box Info**
- **Back to Main Chart / To Next Higher Black Box Level**

Layout to Clipboard

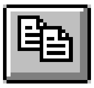
Layout
- **Save As**...
- **Load**...

Module Bar
- **New**
- **Open**...
- **Save As**...
- **Set to Default**

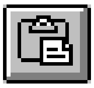
Undo



Cut



Copy

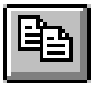


Paste

Delete

Search for Module

1.2.1 Worksheet to Clipboard



Use the Worksheet to Clipboard command from the Edit menu, or click this icon on the Function Bar to create a Windows Metafile image (WMF/CLP) of the worksheet on the Clipboard.

The worksheet is always copied to the Clipboard as displayed on screen, including any changes you have made since last saving it.

The worksheet background is not copied, even if you have selected a color and a grid for it. For further information on these options, see Customizing the ***ServiceLab*** Screen.

The image on the Clipboard is automatically scaled to the size of the ***ServiceLab*** worksheet. If the worksheet consists of only a few modules these will appear larger on the Clipboard than if you have used a large number of modules all over the worksheet.

Use the Paste function provided in any Windows application (usually in the Edit menu) to transfer the metafile from the Clipboard to applications such as Paintbrush or Word for Windows for further use.

1.2.2 Black Box Module

Use the Black Box module to create worksheet elements frequently required in your experiments, integrate them into one module (the Black Box) and insert them into future worksheets as ready-to-use units. Similar to an integrated circuit, a Black Box module contains a portion of the worksheet.

Use Black Box modules to implement standardized modules that perform customized algorithms not provided by ***ServiceLab***. These menu commands provide all the functions necessary to organize Black Box files.

For further information on the modules themselves, on how to create and edit Black Box worksheets, and on the corresponding Module menu commands refer to Module Reference Guide.

Save As...

To save a Black Box:

- First, open the Black Box you wish to save. You cannot save a Black Box while the ***ServiceLab*** main chart is active.
- Make sure you have entered a Module Name and an ID Tag in the Black Box Info dialog box.
- ***ServiceLab*** can only list a Black Box file on the Module menu if a Module Name has been entered for that Black Box before saving it.
- ***ServiceLab*** can only install a Black Box icon on the Module Bar if an ID Tag was entered for that Black Box before saving it.

⇨ *The Black Box Info dialog box will appear when you try to save the Black Box if the identifying tag is missing.*

- Then choose Save As... from the Black Box Module submenu of the Edit menu. Specify the Name, Directory, and Drive of the file to be saved. ***ServiceLab*** automatically adds its standard extension for Black Box files (∗.DBB).

⇨ If you save a worksheet containing a Black Box, a complete copy of the Black Box will be included with the worksheet.

If you modify the original Black Box file independently, the Black Box saved with the worksheet will not be updated. To insert the new version first delete the previous Black Box version from the worksheet.

The advantage to this system is that if you modify or delete the Black Box file, it will not cause errors in the worksheets incorporating (and possibly based on) the functions and settings of the original Black Box.

Black Box Info

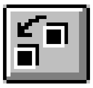
Enter descriptive texts and identifying tags for the Black Box module.

- The Module Name identifies the module symbol in the worksheet.
- The Black Box module symbol in the main chart (or the preceding worksheet level) displays its name in its Title Bar.
- The first 20 Black Box files in the ***ServiceLab*** directory (not the Worksheet directory!) automatically appear as menu items on the Black Box module submenu of the Module menu after the program has been started. Their Module Names appear as menu commands.
- Enter a short comment in the Description box to describe the functions implemented by the Black Box.
- The ID Tag is a string of up to 3 characters that is used to identify the Black Box module in the Module Bar. The Module Bar icon representing that Black Box displays that tag.

⇨ *A Black Box can only be saved if the ID Tag has been entered. The Black Box Info dialog box will appear when you try to save the Black Box if the identifying tag is missing.*

Back to Main Chart / To Next Higher Black Box Level

You can insert another Black Box module in a Black Box worksheet. The module can then contain a Black Box module, and so forth, down to any level. Thus, the worksheet becomes three-dimensional, with the Main Chart (the actual ***ServiceLab*** work area) and several subordinate Black Box levels, each one embedded into the preceding level.



You can open any Black Box by clicking its module symbol on the worksheet; you can leave it again to return to the next higher worksheet by clicking this Function Bar icon, or by choosing the command from the Black Box Module submenu on the Edit menu.

The command can have two names: either Back to the Main Chart (if the current Black Box is an element of the Main Chart), or To Next Higher Black Box Level (if the current Black Box is itself an element of another Black Box worksheet).

After a Black Box has been closed, the worksheet on the next higher level is displayed.

If you start an experiment from a Black Box worksheet, the program will first return to the Main Chart before acquisition begins.

You can enter a Black Box and activate its worksheet for editing by double-clicking its module symbol on the worksheet.

By default the worksheet of a new Black Box has a blue background. Color settings can be selected individually for each Black Box. Choose the Colors command from the Options menu to do so.

Background color can be used as an indicator of the Black Box level. It will be easier to find your way through several worksheet levels without losing orientation by attributing a different background color to each of these levels.

1.2.3 Layout to Clipboard

Use this command to copy the Layout Window as a Windows Metafile (WMF/CLP) to the Clipboard.

The layout is always copied to the Clipboard as displayed on screen, including all the changes made since last saving it. The Layout will not be modified.

The size of the Layout Window in the Clipboard is automatically matched to the size of the area used on the ***ServiceLab*** worksheet. If you arrange only a few small elements they will appear larger on the clipboard.

Use the Paste function in any Windows application (usually in the Edit menu) to copy the metafile from the Clipboard to applications such as Paintbrush or Word for Windows.

1.2.4 Layout

Save as...

Use this command to save a Layout Window with a new name or to place it into another directory.

You can select the file name, the directory and the disk drive where the file is to be stored.

- Type the file name in the File Name box. (Note that the file name must be chosen in accordance with MS-DOS conventions.)
- If you do not type an extension, ***ServiceLab*** automatically adds its standard extension for Layout file names (∗.LAY). (***ServiceLab*** always saves Layout files in a specific format, even if you select an extension other than ∗.LAY.)
- You can...
  - … Select one of the file names offered on the list by double-clicking on the file name. The file will be replaced with the Layout.
  - … Select a different directory (double-click the directory name)
  - … Select a different drive for the new file
  - … You can select the type of files in the List Files of Type box (defined by their extension) to be listed in the box above.

If you wish to use your keyboard, press the `TAB` or the `SHIFT+TAB` keys to move from one field to another; select items from the lists by pressing ↑, ↓, `SPACE` and the `ENTER` key.

You can specify a standard directory for Module Bar files (Options menu command).

Load...

Choose this command to load a Layout previously saved to a file.

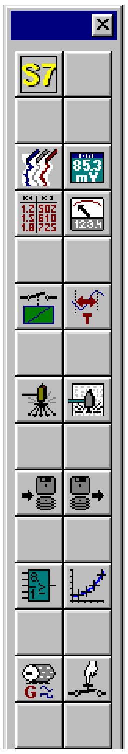
Type the file name in the File Name box. (Note that the file name must be chosen in accordance with MS-DOS conventions.)

You can...

- … Select one of the file names presented in the list by double-clicking on the file name.
- … Select a different directory (double-click the directory name),
- … Select a different drive for the new file.
- … You can select the type of files in the List Files of Type box (defined by their extension) to be listed in the box above.

If you wish to use your keyboard, press the `TAB` or the `SHIFT+TAB` keys to move from one field to another; select items from the lists by pressing ↑, ↓, `SPACE` and the `ENTER` key.

1.2.5 Module Bar



The Module Bar, at the left of the ***ServiceLab*** window, displays a selection of frequently used modules in icon form.

Use the **left** mouse button to click the icon for the module you want to add to your worksheet or select the module from the Modules menu. Since there are only a limited number of spaces on the Module Bar, not every module can be displayed.

You can customize the Module Bar by clicking on a square in the Module Bar with the **right** mouse button to assign any of the modules available in ***ServiceLab*** to that button. You can customize a Module Bar for individual experiments.

The menu commands provide the functions necessary to modify the Module Bar for your requirements and to organize the Module Bar files.

New	provides a blank Module Bar to be configured
Open...	opens a saved Module Bar
Save As...	saves the current Module Bar configuration to a file under a name of your choice
Set to Default	opens the default Module Bar

To enlarge the work area for your worksheet, Remove the Module Bar from the screen. The visible work area will extend to the left border of the ***ServiceLab*** *window. Use the Module Bar command on the View menu to remove and to re-display the Module Bar (see page 4-39).*

After you have removed the Module Bar, you can still use all the modules by choosing the Module menu commands.

All of the Module Bar settings are automatically saved with information about the window size and position when you exit the program and when you choose the Save or Save As... commands from the File menu.

New

*Choose this command to create a new Module Bar. The current Module Bar on the **ServiceLab** screen will be cleared and you can assign the module of your choice to each button.*

Click on a square in the Module Bar with the **right** mouse button to assign any of the modules available in ***ServiceLab*** to that button. A dialog box appears presenting the complete list of modules including their Module Bar icons.

- To select a module in this list, type the first letter of its name to move to the first matching module. Type the letter again to move to the next module that starts with that letter.
- Click the Help button to obtain information on the selected module.
- Choose OK, or press ENTER, to install the selected module on the Module Bar. The Module Bar will now display the new icon.

The Module Bar settings are automatically saved when you exit the program.

To save a configuration permanently, or to configure several Module Bars for individual experiment tasks or users, choose the Save As... command from the Edit / Module Bar menu.

Open...

Choose this command to open a saved Module Bar.

You can select the Module Bar file from a list of files presented in a dialog box, using the standard Windows conventions. The default file extension (.DML) will be used to create a list of ***ServiceLab*** Module Bar files.

Type a different extension here if you have saved ***ServiceLab*** Module Bars with extensions other than .DML.

⇨ ***ServiceLab** can only open Module Bar files in its own DML format, no matter what extensions the files have.*

⇨ *When you open a Module Bar file, any modifications of the current Module Bar on the screen are lost, unless you have saved them using the Save As... command from the Edit / Module Bar menu.*

You can specify a standard directory for Module Bar files (Options menu command).

Save As...

Choose this command to save the current Module Bar on the ***ServiceLab*** *screen to a file.*

You can select the file name, the directory and the disk drive where the file is to be stored. If you do not type an extension, ***ServiceLab*** will add the standard extension for Module Bar file names (.DML).

You can specify a standard directory for Module Bar *files (*Options *menu command).*

Set to Default

Choose this command to open the default Module Bar configuration onto the ***ServiceLab*** *screen.*

The default Module Bar will be installed without further dialog. Any modifications of the current Module Bar on the screen will be lost, unless you have previously saved them.

The default Module Bar is not saved in a DML file but is saved internal to the program. Therefore, you cannot change its setup.

The ***SERVICELAB*****.**`DML` *file always contains the Module Bar configuration that was active when you last exited the program.*

1.2.6 Undo

Choose this command to undo *the last autorouter operation (moving or connecting modules).*

Other worksheet changes like changing module settings, adding or deleting module input or output channels cannot be restored. Choose this function using the menu or by the `ALT+Backspace` key combination.

1.2.7 Cut, Copy, Paste or Delete Flow Chart Parts

Modules and module groups with connections can be deleted, moved or duplicated.

Selection: First select the modules: click and hold the **left** mouse button inside the worksheet and select the area by dragging the cursor across the area. When you release the mouse button, the selected modules are highlighted. You can select or deselect single modules by clicking the **left** mouse button on the module while pressing the `SHIFT` or `CTRL` key.

Cut: To move modules around the worksheet, choose the Edit/Cut menu command or the `SHIFT+DEL` or `CTRL-X` key combinations. All connections to unselected modules are deleted.

Copy: Choose the Edit/Copy menu command or the `CTRL-INSERT` or `CTRL-C` key combinations. The selected modules will be inserted onto the worksheet with their channel settings intact.

Paste: Paste the stored worksheet part by choosing the Edit/Paste menu command or by pressing `SHIFT+INSERT` or `CTRL-V` at any position on the worksheet. After activating the insert mode, the mouse cursor changes. Choose the position where the selection should appear. The entire worksheet can be used. The window is scrolled automatically when the mouse cursor moves outside the window border. Once the mouse cursor is at the destination press the **left** mouse button to paste the cut chart modules into the worksheet, if there is enough room for the operation. The paste operation can be repeated.

You can use the cut and paste function to integrate worksheet parts into a black box, but references to those modules in Actions will need to be edited to reflect the new name.

You cannot cut or copy hardware modules, including analog/digital inputs, outputs, counter modules or black boxes.

1.2.8 Delete

Choose the Delete menu command or the Delete key to delete the selected modules.

1.2.9 Search for Module

This function offers you an easy way to find each module used in complex worksheets. This menu item opens a list box, in which all used modules are listed (including their position in black boxes). Double mouse click on one of the listed modules to move to the module and mark it. This function is also available in the popup menu that will be open with a left mouse click on any empty area of the worksheet.

The modules may be sorted by name, module type or by Black Box.

Double click on one of the listed modules to move to the module and mark it. This function is also available in the popup menu that will be open with a left mouse click on any empty area of the worksheet.

The Open Button at the bottom of the list window opens the Properties dialog box for the selected module.

1.3. Module Menu

Full details for each module are in the ***ServiceLab*** Module Reference Guide, published as a separate volume.

1.3.1 Module Groups

Use the Module menu functions to select any of the modules provided by ***ServiceLab*** to insert into your worksheet.

Within the Module menu, select a Module Group. A Module Group is made up of a number of modules providing similar functions. The Module menu provides the following module groups:

Input/Output

Trigger Functions

Mathematics

Statistics

Signal Analysis (optional)

Control

Display

Files

Data Reduction

Network (optional)

Special

1.3.2 Modules

Choose a module group to display a submenu with the individual modules belonging to that group.

Module Symbols

A module represents a functional element in the ***ServiceLab*** experiment setup (worksheet). A worksheet can contain up to 256 modules. Each Black Box module can also contain up to 256 modules, including other Black Box modules.

The **functions** symbolized by the modules provide all the operations required for an experiment,

- From data acquisition (by a data acquisition board) or signal generation (simulated by a virtual generator)
- To data analysis, evaluation and processing (mathematics, statistics, control, trigger and other functions)
- Up to their presentation on screen (display instruments) or export for documentation purposes (printer, metafile, etc.).

Each of the available modules in ***ServiceLab*** is shown in two forms, both indicating the module's function: Module Bar icons and worksheet symbols.

A limited number of module icons can be installed on the Module Bar. They can be placed on the worksheet by a single mouse click on the Module Bar icon. Any module can be installed on the Module Bar, including Black Boxes that you have previously saved.

☝ *You can configure the Module Bar according to your specific requirements. You can save various configurations to files for later use. For details, please refer to Chapter 4 of this manual.*

Installing Modules

A module can be installed on the worksheet either by choosing it from the Module menu or by clicking its icon on the Module Bar. Either way, the module will be placed on the worksheet as a module symbol. For modules that provide more than one basic operation, you must also select the function type.

Choose a Module Group from the Modules menu to display a submenu with the individual modules that belong to that group. The submenus list **all** the modules currently available. You can select any of the modules by clicking on its name. If a module is not available in your version of the software it will be gray, and you will be unable to select it.

A worksheet can contain up to 256 modules, including Black Box modules.

Configuring Modules

Use the **left** mouse button to double-click on the module's worksheet symbol to open the Properties dialog box to configure the module. The following parameters can generally be specified in the dialog box:

- The Module Name,
- A short Description,
- The number of inputs/outputs (up to 16 for most modules).

Once you have activated more than one channel, you can select each of them to display and define specific channel parameters.

Use the `F7/F8` function keys to easily configure several channels for one module.

For specific module settings, please refer to the individual module descriptions. The general parameters are described in the Module Reference Guide. The specific module settings are described in the sections for each module.

Connecting Modules

A data channel is the connection between the output of a module and the input of another module. Data is transferred between modules via these connections.

In the ***ServiceLab*** work area, lines like the ones shown below show connections, which always connect the output and input symbols of the module symbols. By creating junction points and branches, you can connect each module output to up to 16 inputs of other modules.

Data channel
junction points and branches
***no** connections*

For details on how to create, delete and rearrange data channels and branches, refer to Chapter 3 of this User's Guide.

While the experiment is running, you can hold the CTRL Key while you left click on the data channel to get further information about the connected modules.

Moving Modules

A module can be moved to any position on the worksheet by dragging and dropping its worksheet symbol. Click on the worksheet symbol with the **left** mouse button and, while holding the mouse button down, drag it to any position. When the mouse button is released, the module symbol will automatically be aligned based on the spacing value entered in the Window Setup box of the Options menu.

Select Modules

Click on the worksheet symbol with the **left** mouse button or draw a box around the module (or modules) while holding the mouse button down. All modules within the frame will be selected.

Copy Modules

Selected modules can be copied using the Main Menu command Edit: Copy.

Paste Modules

Selected modules can be pasted into the worksheet using the Main Menu command Edit: Paste.

Deleting Modules

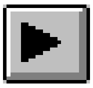
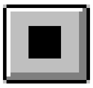
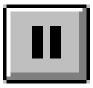
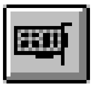
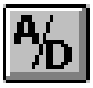
Modules can be deleted by double-clicking the worksheet symbol with the right mouse button. This opens a dialog box allowing you to remove the module or to delete its input or output connections. Modules also can be deleted using the Edit command of the Main Menu.

Search for Modules

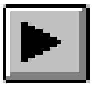
You can search for installed modules with the Search for Modules command. You can select the command from the Edit menu or from the dialog box that appears when you double-click on the worksheet symbol with the right mouse button. The Search for Modules command opens a list box with all installed modules and black boxes. When you double click with the left mouse button on the desired module, ***ServiceLab*** jumps to the module icon in the worksheet.

1.4. Experiment Menu

The most frequently required commands from this menu can also be chosen by clicking the corresponding icons on the Function Bar or by using keyboard short-cuts (Hotkeys).

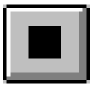
	***Start***	`F5`	***Start experiment***
	***Stop***	`CTRL+F5`	***Stop experiment***
	***Pause/Resume***	`CTRL+F6`	***Pause or resume paused experiment***
	Start/Stop at Time…		
	Auto Start		
	Select Driver…		
	***Hardware Setup…***		
	***Experiment Setup…***		

1.4.1 Start



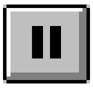
Choose the Start ***command from the*** Experiment ***menu or click this Function Bar icon, or press*** `F5`***, to start an experiment***.

1.4.2 Stop



Choose the Stop ***command from the*** Experiment ***menu or click this Function Bar icon, or press*** `CTRL+F5`***, to stop an experiment completely. All pipes will be cleared of data***.

1.4.3 Pause/Resume Experiment



Choose the* Pause *command from the* Experiment *menu or click this Function Bar icon, or press* CTRL+F6*, to pause the running experiment. (√indicates that the experiment has been interrupted.)

This command stops the acquisition of new data, for example from a signal generator module, an A/D or digital input module, a PID or manual control. Data already acquired and still in the pipes will be retained, however, and processed completely.

The Pause/resume command is available only if the worksheet does not contain any module accessing the data acquisition hardware. The reason is that ***ServiceLab*** derives its own clock from the board's master clock. This is not available if the measurement is paused. To pause a running experiment, use the Stop module.

1.4.4 Start/Stop Experiment at Time…

Choose this command to start, stop, and repeat an experiment at a specified time.

The dialog box that appears provides three fields where you can specify the time at which an experiment is to start, the duration of that experiment, and the interval after which that experiment is to be repeated.

Select the function by clicking its option button: Start Experiment at Time, and/or Stop Experiment after Time, and/or Restart Experiment after Time. A check mark (✓) next to the option button indicates that the function has been activated.

Then enter the time specifications:

- Start Experiment at Time/after delay: Specify the time at which the experiment is to begin. The default setting is the current date and time plus five minutes. You may either type the values for the date, the hour, the minutes, and the seconds, or press the UP ARROW (↑) or DOWN ARROW (↓) keys to scroll, or choose the values from the drop-down list.
- Stop Experiment after Time: Specify the duration of the experiment. The default setting is five minutes.
- Restart Experiment after Time: Specify the interval after which the experiment is to be repeated. There is no default setting for this interval. When this function has been activated, the experiment will be repeated according to the specified data until you:
  - Stop the experiment, or
  - Deactivate this function by clearing the option button in this dialog box, or
  - Modify the current worksheet, or

- Open or create another worksheet.

While any of the Start/Stop by Time functions are active, a message is displayed on the status bar reminding you of the time at which an experiment is due to start or stop.

The settings specified here are not saved when you exit the program nor with the worksheet when you choose the Save *or* Save As... *commands from the* File *menu.*

1.4.5 Auto Start

Choose Auto Start, indicated by a check mark (✓), to prepare the experiment setup for an automatic start later on. Enter the ***ServiceLab*** command followed by the worksheet file name (for example, in the DOS Command Line box of the Program Item Properties dialog box of the Windows Program Manager) to start the experiment directly.

See Automatic Experiment Start in Chapter 6 for further details.

This setting is automatically saved with information about the window size and position when you exit the program. The same configuration will appear the next time you start ***ServiceLab****.*

These settings are ***not*** *saved with the worksheet when you choose the* Save *or* Save As... *commands from the* File *menu.*

1.4.6 Select Driver…

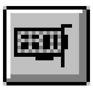
ServiceLab supports a wide range of data acquisition hardware from different vendors. You will typically need a different hardware driver for each manufacturer's data acquisition hardware. If you have more than one hardware driver installed on your system you may switch between them using the Select Driver function.

Note that only one driver can be used at a time.

The Select Driver dialog box lets you select one out of the installed hardware drivers. The change only occurs after exiting and restarting ***ServiceLab***.

If you do not see your hardware driver in the list, ensure that you have correctly installed the driver.

1.4.7 Hardware Setup…



If you have installed a data acquisition device in your system, you must set its parameters in this box.

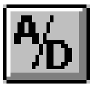
The values entered here must correspond exactly to the configuration of your data acquisition hardware to ensure correct data processing by ***ServiceLab****.*

Choose the Help button, or press F1, or choose Hardware from the Help menu, to obtain help on the settings.

If you have to exchange worksheets between several PC's (as in runtime applications), you must guarantee that the selection and sequence of measurement in ***ServiceLab*** is exactly the same as in your target PC.

Read the Hardware Installation Manual *for further information concerning installation and operation of your data acquisition device.*

1.4.8 Experiment Setup...



Use this command to set the general parameters for data acquisition and measurement control.

Together with the resources provided by your system and the size of the worksheet you have designed, these settings determine the overall data processing performance as well as the response time of the individual functions. Available settings are:

- The Sampling Rate per Channel
- The Global Block Size

  You can use Global Variables to define the sampling rate and block size settings. The variables are read once at the start of the experiment. You **CANNOT** use variables to change these settings while the experiment is running.
- The global settings for Analog Output and Digital Output
- The Synchronization mode that determines the clock source for all internal data sources of ***ServiceLab*** (Generator, Slider, etc.). The two modes available are PC Clock and Data Acquisition hardware.
- Disk Streaming options
- The Driver Settings, which contain - depending on the installed hardware - the driver buffer size, the acquisition mode and the connected parameters Blocks per Series and Delay.

To internally equalize measurement time and system time in the analog input, digital input and counter hardware modules, use the following settings:

- *Synchronization: PC clock*
- *Sampling rate: ≤ 5 Hz*
- *Block size: = 1*

Sampling Rate per Channel

If you operate channels at differing sampling rates, enter the highest sampling rate here. The value entered here always defines the sampling rate for **all** the chan-

nels. You can specify whether this value represents Hertz, Kilohertz or Megahertz or minutes, seconds or milliseconds respectively.

You can also use Global Variables to define the sampling rate and block size settings. The variables are read once at the start of the experiment. You **CANNOT** use variables to change these settings while the experiment is running.

If you wish to operate some channels at lower rates, you must reduce the data rate by using the Separate or Average modules. This procedure yields channel rates that are true divisors of the fastest rate (the global rate).

If you set a sampling rate which is too high for the data acquisition board type in your system, or if the overall sampling rate is too high because you have too many channels at high sampling rates, you will be alerted by ***ServiceLab****, either before exiting this box, or before exiting the Analog Channel selection box. The sampling rate will automatically be rounded up or down to the nearest acceptable value.*

With many of the data acquisition boards supported by ***ServiceLab***, the board itself generates the sampling rate. It is possible to enter a value not supported by the hardware. However, ***ServiceLab*** will automatically adjust the value.

If you use interrupt-driven boards at acquisition speeds too high for the system, some interrupts and the corresponding samples may be missed. The indicator at the bottom left of the ***ServiceLab*** window right to the buffer indicator shows whether ***ServiceLab*** has detected such a situation. If this indicator flashes in yellow, interrupts have been lost, If the amount of lost samples is greater than 2%, the experiment is aborted.

Some boards are not able to indicate lost interrupts by a hardware flag. In this case, ***ServiceLab*** tries to look for lost interrupts by software. This software solution does not guarantee that all lost samples are detected. With these boards it is possible that samples are lost without any indication.

Driver Buffer

Use this option to specify the temporary driver buffer memory size for the hardware driver to use to store data.

The hardware Driver Buffer temporarily stores data coming in from the data acquisition hardware before the software processes it. The driver first stores the acquired data to this buffer, and then ***ServiceLab*** reads the data from the buffer.

During time-consuming operations, such as moving windows on the screen, the driver continues writing data to the buffer, so that no data is lost. Data acquisition will be stopped when the buffer memory is full. You may see the error Sampling Rate too Fast when this happens.

You can enter a driver buffer size between 4 Kbytes and 16,384 Kbytes. The default setting is 64 Kbytes. If the on-board memory resources of your computer are limited, enter a smaller value. You will be warned if the value you have entered is not valid.

⇨ The board driver will use the memory buffer selected;
neither ***ServiceLab*** nor Windows can use it.

⇨ *The buffer size should be increased if you use a high global acquisition rate. Note that the driver buffer setting should not exceed 50 to 75% of the total available physical memory.*

Block Size

Use the Block Size to set the number of samples that will be processed by worksheet modules during a single processing cycle.

Any value from 1 to 32768 can be entered here; powers of 2 are preferred.

The input modules collect the specified number of samples before passing them on to other modules.

You can also use Global Variables to define the sampling rate and block size settings. The variables are read once at the start of the experiment. You **CANNOT** use variables to change these settings while the experiment is running.

Computing the data in blocks increases the speed of the measuring process considerably; but it strongly influences the real-time performance of the system. Therefore, the block size should be selected carefully, taking the following principles into account:

- For a high data transfer rate, but a long latency period where the response time of subsequent modules, like control modules, is slower, use a large block size.
- For a short latency period, where the response time of subsequent modules is faster, but the data transfer rate is lower, use a small block size.

The actual data transfer capacity of a system depends upon many factors, therefore, a general formula for how to determine the ideal block size cannot be provided.

Generally, fast data acquisition operations require large block sizes, while small block sizes work well for slow data acquisition and control operations.

We suggest that you initially set the block size to half the sampling rate (the default setting), and then try out various other values to determine the best value for your individual task.

Acquisition Mode

The available Acquisition modes depend on the installed hardware and the modes supported by the driver.

- Continuous mode: When continuous mode has been activated, indicated by a check mark (✓), the data will be acquired without interruption at the specified sampling rate and processed by ***ServiceLab***.
- One Series: After the experiment start, the data will be acquired without interruption at the specified sampling rate the amount of data defined by the parameter Blocks per Series setting has been reached.
- Running Series: This mode is a repeated one series mode. After the specified number of blocks the acquisition is interrupted for at least the time specified by delay. If the delay is too short for ***ServiceLab*** to process the data, the acquisition is delayed for a longer time.

  The display modules do not recognize the delays. That means that in this mode there is no correspondence of time of day for the data samples. They are treated as continuous data in ***ServiceLab***.

  This mode is especially useful for fast scope applications.
- Isolated Series: This is the same mode as the Running Series, except that ***ServiceLab*** recognizes the gaps. The resulting data stream is not continuous.

  Quite obviously, this method leads to **acquisition gaps** between the blocks. Their size depends on the number of active channels, on the block size, on the complexity of the ensuing processing arrangement, and on the hardware resources.

  This mode may be useful in cases where a high sampling rate is essential, while continuous high-speed data acquisition and processing cannot be realized, e.g. due to limited hardware resources.

  If you wish the acquisition to stop after a certain time, enter the corresponding number of values in the Count field. (This value can be freely specified for each channel.) After that number of data has been acquired, the acquisition will be stopped automatically. (The default setting for this field - **zero** - means that the acquisition process is **not** supposed to be aborted when a certain number of values have been acquired.)

Analog Output and Digital Output

Set the general output parameters for analog and digital output individually.

Output Mode: The output mode determines whether the data samples are sent out synchronously with the acquisition rate or asynchronously, which means as fast as possible but in undetermined intervals.

- In the synchronous mode, data samples are sent out according to the acquisition rate specified for each output channel.

- In the asynchronous mode, data is sent out as fast as possible. The maximum rate depends on your hardware, the speed of your PC and the complexity of the worksheet. You should experiment with these rates to find out the best combination for your individual task.

Output Buffer

- If the Fill once option is selected, the output buffer will be filled only once, with the first block of data coming in after the experiment start. When the buffer is full, that first block of data will be sent out repeatedly, always beginning with the first data again. Any further values coming in from the worksheet will be ignored.
- If Continuous refill is chosen, the output buffer will continuously be filled with the data samples coming in from the worksheet, and these samples will then be sent out.
- Output Rate: The output frequency defined in this list box only takes effect when the synchronous mode is selected. Only frequencies that are an integer divider of the global acquisition rate are allowed. Changing the global acquisition rate also affects the output rate.
- Output Start: The value entered in the Output Start list box defines the number of samples that are to be collected before the analog output actually starts. This value must be the same as the global block size, or a multiple of it. This feature can be used for a defined delay or to synchronize the values that come from the worksheet.

Disk Streaming

This option enables or disables the fast storage of measurement data samples as they are acquired.

Disk Streaming provides the ability to write ***ServiceLab*** data onto a mass storage media. Unlike the Save Data module that writes data of the data stream of up to 16 data channels into a file, Disk Streaming stores the data of all channels in a highly compressed 2-byte integer format. The amount of required mass storage space is reduced and the time to write the data procedure is much faster since only a fractional part of the data is produced. Additionally, the conversion of the integer data of the driver into the floating-point data of ***ServiceLab*** is skipped. This is the main reason why Disk Streaming can write data sampled at high Acquisition rates to the mass storage device.

*No other channels should be connected to the **A/D**, **Digital** or **Counter input** modules, since this would significantly reduce the time advantage.*

Disk Streaming settings are made in the Experiment Setup dialog box. Disk Streaming can be enabled or disabled by checking the Active box.

Select the File Name button to change the name of the streaming file. Then, a file selection window opens to enter a file name.

⇨ *You can set the Default Directory for Disk Streaming files in the Options menu.*

Data samples are stored in the **DASYTEC** data format (Universal Format 0). You can find a description of the data format in Chapter 5 of this manual.

Options

- Warning if Channels are Connected

  If this option is enabled, a warning message will be issued and the measurement is immediately stopped if channels are connected to the Analog, Digital or Counter Inputs.

- Don't Overwrite Existing Files

  This option prevents overwriting an existing Disk Streaming file. The measurement is stopped immediately after starting. A message is displayed if a file with the specified name exists and would be overwritten.

- Circular Buffer

  This option implements an in-memory buffer, containing the last **n** Blocks per Channel.

Disk streaming files are read (as other data files) using the Read Data module. If the file to be loaded is a Disk Streaming file, the information Universal 0 is shown in the Data format text field of the dialog box of the Read data module. ***ServiceLab*** data files written without Disk Streaming are stored in the Universal 1 data format.

Use the Channel group combo box to select which channels you want from the data stream: Analog 0 identifies the first 16 scanned analog channels, Analog 1 the next 16 scanned analog channels and so on. The same applies to Counter X. For Digital port X the selected port will always be displayed, as it was saved with the original worksheet.

Hints for Optimal Measurement Settings

Block Size/Sampling Rate

The performance of ***ServiceLab*** depends primarily on the sampling rate and block size.

The sampling rate controls the resolution of the received signal (data bytes). The block size affects the response time of the worksheet. The response time is determined by the ratio of sampling rate and block size (S/B ratio). A **poor setting** causes data to accumulate in the driver buffer, shown by the Status Bar (the green/red bar lower right in the worksheet main window.) If the driver buffer is filled, ***ServiceLab*** displays the **"Experiment stopped. Sampling rate too fast!"** error message.

General Hints for Sampling Rate and Block Size

In the data acquisition program the data is sent as data blocks via the connected data channels between modules. ***ServiceLab*** works in a block dependent mode. Each module output has a 64 Kbyte buffer to hold the processed data. The module at the end of a branch periodically checks whether a data block is available in the buffer. If the answer is yes, the block is transmitted, processed and placed in the output buffer to be processed by the next module.

Each block contains measurement data, called samples, and a block header. The header contains information about the block, including the data type, the start time of the block and the sample interval. The program calculates a time stamp for each sample. Many modules verify the time stamp and data type to ensure that only samples with the same characteristics are processed together.

Many multi-channel modules start processing data only if all inputs have data with the same time stamp. If there is no data at available one input, the module cannot process data at other inputs, and may start to block the data flow.

The module input buffer will fill until it is full. Because that module is unable to process data, the buffer of the preceding module will be filled up. The end result is that several branches of a worksheet will stop to work.

The first hint will be the "Animation bar" shown at each output in each module symbol. If the animation stops, the module is no longer processing data. Detailed information can be found in the channel debugger. Left click with CTRL key pressed on the data channel (with measurement running!). Important entries are "FIFO blocks" (max. buffer size) and "used" (buffer usage).

If you use different kinds of data in a multi-channel module (sampling rate, block size or type of channel...), the module can't process the different samples together. ***ServiceLab*** will show a message like "Time information or block size is different. These channels can't be processed together. " and measurement stops.

The response time of ***ServiceLab*** depends mainly on the ratio of block size and sampling rate.

- The block size defines how many samples are collected as a data packet and are sent as a block to subsequent modules.
- The sampling rate defines how fast the data is generated or acquired by the data acquisition board.

The resulting update interval of the worksheet depends on the fact that a new block will only be released and processed once it is filled with samples.

The following example will show the context:

The following response times are will be expected with different setting for block size and sampling rate.

Block size	***Sampling rate (1/sec)***	***Minimum response time (sec.)***
1	1	1
1	1000	0.001
1000	1	1000

The smaller the ratio of block size to sampling rate, the more frequently the worksheet will refresh (Visualization/Display elements).

⇨ *If you use too small a block size (e.g. 1) the message ”Measurement stopped. Sampling rate too high” may appear, and the program stops!*

Explanation of Response Time

When a new module is placed on the worksheet, it is placed in a module management list. The ***ServiceLab*** dispatcher manages the distribution of CPU time to each module in that list. There is a physical speed limit that depends on the size of the worksheet (number of modules and data channels) and the hardware configuration of the PC, because the dispatcher has to process all modules during the refresh time. For example, take a worksheet with 100 modules/data channels and a sampling rate/block size ratio (S/B ratio) 1/1000. In this case, the dispatcher has just 1 msec to process 100 modules. Each module gets 10 µsec to process the received data. That time simply is too short, data will start to back up, and eventually the program will be halted!! An accurate examination of your experiment should define the sampling rate (resolution) of your measurement. The dispatcher’s cycle time is defined by the block size and parallels the time to process the acquired data. The block size also defines boundary conditions such as the refresh rate of the visualization elements, range of the FFT and so on.

⇨ *In our experience it is advisable to select a **S/B ratio from 1 to a maximum 10**.*

⇨ ***ServiceLab** has the option to show the system capacity usage (ratio of needed CPU time and max. available CPU time). You can see at the start at the measurement whether your system has enough capacities to fulfill the requirements of the measurement.*

Hints for the resulting amount of data

The quantity of data to be transferred that loads the system also depends on the S/B ratio and increases with a rising S/B ratio. Each block of data includes a **26 Byte** sized **Header** that has to be transferred with each block. If you use a block size of 1, the block has 4 actual data bytes and 26 bytes Header data, causing the system to transport more overhead information than actual data.

Example:

S/B ratio: 1000

Block size 1; Sampling Rate 1 kHz; 100 Data channels

Useful Bytes:

4 Byte * 1000 Hz *100 = 400.000 Byte

Header:

26 Byte * 1000 Hz*100 = 2.600.000 Byte

Sum:

3.000.000 Byte

S/B ratio: about 2

Block Size 512; Sampling Rate 1 kHz; 100 Data Channels

Useful Bytes:

4 Byte * 1000 Hz *100 = 400.000 Byte

Header:

26 Byte * 1000 Hz/512*100 = 5.078 Byte

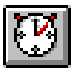
Sum:

405.078 Byte

The same principle has to be considered when storing data to hard disk when using the DASYTEC file format. Long duration measurement sessions with small block sizes may create unexpectedly large files. For low speed, long duration files, consider using the ASCII or IEEE32 file formats to minimize file size. You may want to experiment with different settings to determine the optimum configuration.

1.4.9 Time Base Setup

Time Base Global Setting



Use this command to configure the available time bases for your experiment.

You can use different Time Bases to synchronize data flow.

All time base settings can be configured here. Each available Time Base generates a tab on the top of the dialog box, to directly select the corresponding time base setup.

Basically ***ServiceLab*** offers two time bases:

- PC Clock: The standard time base is a free-running timer synchronized with the PC clock. The default setting for the sampling rate is **10Hz**, with a block size of **1**. You can change these settings to meet your specific requirements. Use this time base in modules that don’t have a direct connec-

tion to the regular driver based data flow (e.g. Switches to control actions).

- Driver**:** The driver time base is synchronized with the driver interface and is used for data acquisition with the installed hardware. The available settings depend on the installed DAQ Hardware.

There are additional DLL drivers that use their own sampling rates (NI-DAQ, NI-CAN, instruNet, etc.). If one or more of these drivers are installed, the Time Base Setup… will display additional tabs in the dialog box.

Selecting Time Bases in a Module

Data generating modules (such as Generator without Modulation, Switch, Slider, Coded Switch, TTL Generator, Time Base without control input, and Sequence Generator without control input) provide a setting to select one of the available time bases allowing you to synchronize the module to a specific data flow. In most cases you don't need to use a control input or synchronization.

Tips for using different Time Bases

If you need a quick reaction to an event, it is recommended that you use small block sizes (1 if possible). If you set up your flowchart with a "useful" relation between sampling rate and block size (~ 1:10), you must set the block size from 100 up to 1000 using a sampling rate of 1 kHz. That block size is too large to get a fast reaction. You can now use the second time base PC Clock with a separate setting of the block size to 1.

(Also see **Hints for Optimal Measurement Settings** on page 4-30.)

Time Bases of imported (reloaded) worksheets

⇨ *A time base (controlled by hardware), that was used while the worksheet was created, but is not available on the PC at the time that the worksheet is loaded, is still shown, but placed in brackets in the time base dialog.*

Example: The worksheet was created on a system using the NI-CAN hardware. Now it is loaded on a PC without the NI-CAN hardware. In the time base dialog you will find the entry for the NI-CAN time base placed into brackets indicating that time base hardware isn't available.

Regardless, all settings can be made for the unavailable time base and these settings will be stored in the worksheet. If you run the worksheet without the hardware, all modules that use that time base are synchronized to the PC clock. It is likely that they will work correctly with only a small time shift. Please use caution, and ensure that you test the worksheet with the correct hardware to ensure that all timing related functions work correctly. For example, a relay controlled by a PC-clocked switch may work correctly in this mode, but may fail when the actual hardware time base is available.

1.4.10 Serial Devices

You can set up multiple Serial Devices using saved configuration files. This dialog links serial devices to a saved configuration file. When you insert a Serial or ICOM Input or Output module into the flowchart, available linked devices are shown in a selection list. You don't need to load an additional configuration file.

*Please note that any settings made directly in the module properties after saving a configuration file are **not automatically stored** with the flowchart. To save these changes you must use the **Save** button in the module dialog box. Please pay attention that you select the correct configuration file name linked to the selected device name.*

Selection of the Type of Serial Module

You can select one of the available module types:

- Serial In (Master)
- Serial In (Slave)
- Serial Out
- ICom Input (Master)
- ICom Input (Slave)
- ICom Output

Buttons

- OK: Verifies and saves the changes and closes the dialog box.
- Cancel: Closes the dialog box without any changes. Any changes to settings are lost.
- Help: Opens the **Name1 Help.
- Add: Adds a new entry to the list of predefined devices. You can name the new configuration and link an existing configuration file to that entry. If you don't enter a name **Name1 will create a default name by using the name of the assigned configuration file.

  The file types to link are
- for RS232 Input Master module = (*.SIM)
- for RS232 Input Slave module = (*.SIS)
- for RS232 Output module = (*.SOU)
- for ICOM Input Master module = (*.IIM)
- for ICOM Input Slave module = (*.IIS)
- for ICOM Output module = (*.IOU)

*Use a descriptive name to save your configuration files to easily identify a specific device. Then you do not need to enter a specific name for configuration because **ServiceLab** creates a suitable name.*

- Remove: Deletes an entry from the list of devices. You cannot cancel the deletion in the dialog. To restore the entry, leave the dialog using the Cancel button.
- Change: You can rename an entry or change the link to the configuration file using that button.

1.5. View Menu Commands

The commands of this menu allow you to change the appearance of the ***ServiceLab*** worksheet on the screen. You can click on the corresponding Function Bar icons to choose some of these functions.

Overview

Animation (Worksheet View only)

Block State

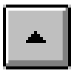
FIFO State

Function Bar

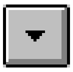
Module Bar

Status Bar

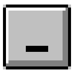
All Windows



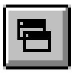
Make Visible (Show)



Make Invisible (Hide)



Minimize



Restore

Select Windows

Make Visible (Show)…

Make Invisible (Hide)…

Minimize …

Restore…

Save Window Arrangement

ALT-x *Select Window Arrangement (1-8)*

Delete Current Window Arrangement

1.5.1 Overview

*Choose this option to display the complete **ServiceLab** worksheet at a reduced size in a separate window.*

The display gives you an overview of your complete worksheet. The display is automatically scaled so that the entire worksheet is shown in the window. A check mark (✓) indicates that this function has been chosen.

⇨ *You **cannot** edit or change the worksheet in the overview window.*

1.5.2 Animation

Choose these option to visualize the data flow by switching the animation (Block Status and FIFO Status) of the worksheet on or off. A check mark (✓) indicates that the function has been activated.

When Animation is active, small colored indicators in the output symbols of each module will display the data flow and buffer (FIFO) status.

Block Status: Displays the status of data block processing. The bar will toggle from red to green, indicating that the module is processing data.

FIFO Status: Choose this option to switch the animation of the FIFO Status in the worksheet on or off (√ indicates that this function has been activated.)

When Animation is active, the load of the FIFO buffer of each module will be displayed by a bar indicator replacing the output symbols of the respective modules above the small bar indicator of the Block Status indicator). The size of the bar changes in **steps of 10 %** depending on the load of the buffer.

To guarantee that the worksheet runs smoothly, the bar should not exceed 10 %. Larger values point to data flow problems that may cause delayed actions, loss of data and, in the worst case, may force the program to stop.

⇨ *Data may be processed more slowly when the Animation function is active, since graphics operations use more system resources.*

1.5.3 Function Bar

*Choose this option to display or remove the Function Bar below the Main Menu Bar of the **ServiceLab** window.*

A check mark (✓) indicates that the Function Bar is displayed.

The Function Bar displays a selection of icons that provide easy access to menu functions often used during experiments. Click the icon representing the function. (For a detailed description of the Function Bar configuration, refer to Chapter 3 of this manual.)

To enlarge the work area for your worksheet, remove the Function Bar from the screen. With the Function Bar removed, use the menu commands or hot-keys. To

start an experiment, for example, choose Start from the Experiment menu, or press the ALT, X, S keys, or press F5.

When the mouse pointer is pointing at a Function Bar icon, a QuickInfo tag with the name of that function will appear. You will find such tags in all of the module windows providing a Function Bar, such as the display windows of the Y/t Chart or the List Display modules.

To redisplay the Function Bar, choose this command from the View menu.

1.5.4 Module Bar

*Choose this option to display or to remove the Module Bar on the left hand side of the **ServiceLab** window.*

A check mark (✓) indicates that the Module Bar is displayed.

The Module Bar displays a selection of frequently used modules in icon form. Use the **left** mouse button to click on the icon that symbolizes the module you want to add to your worksheet. (For a detailed description of the Module Bar configuration, refer to Chapter 3 of this manual.)

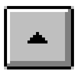
To enlarge the work area for your worksheet, you can remove the Module Bar from the screen. With the Module Bar removed, use the Module menu commands to add modules to the worksheet. For example, choose Display from the Module menu, and then choose Chart Recorder.

To redisplay the Module Bar, choose this command from the View menu.

1.5.5 All Windows

You can use the View Menu to control the state of the Display Windows. There are two modes: Visible/Invisible, and Restored/Minimized. Invisible windows are hidden from view, whether restored or minimized. Invisible windows cannot be restored or minimized. The follow commands apply to All Windows. To change one or more windows, use the Select Windows command of the View menu.

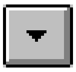
All Windows: Make Visible



Choose this function, or click the icon on the Function Bar, to show all the hidden display windows and icons contained in the worksheet as restored windows or in icon form. This command does not restore iconized windows.

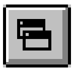
To show only selected hidden display windows, see the Select Windows: Make Visible function.

All Windows: Make Invisible



Choose this function or click on the icon on the function bar, to hide all display windows contained in the worksheet. Minimized windows (represented by an icon at the bottom of the screen) are also hidden. To hide selected display windows, see Select Windows: Make Visible function.

All Windows: Restore

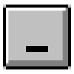


Choose this function or click on the icon on the function bar, to restore all the minimized display windows contained in the worksheet. This command has no effect on invisible windows or icons.

When you first activate ***several*** *display windows* ***of the same type*** *(e.g. Y/t Charts or Bar Graphs) using this function, they will all be automatically opened in the center of the screen, on top of each other. Drag the top window to one side to view the next display window.*

All the minimized display windows will be restored. To restore only one display window, double-click its icon at the bottom of the computer screen or choose Select Windows: Restore from the View Menu.

All Windows: Minimize



Choose this function or click on the icon on the function bar, to **minimize all activated** display windows contained in the worksheet.

To minimize one display window, click its Minimize button (in the upper right-hand corner of the display window).

To re-activate all the display windows contained in your worksheet, choose Normalize Display Windows from the View menu, or click the corresponding Function Bar icon.

1.5.6 Select Windows

You can use the View Menu to control the state of the Display Windows. There are two modes: Visible/Invisible, and Restored/Minimized. Invisible windows are hidden from view, whether restored or minimized. Invisible windows cannot be restored or minimized. The follow commands apply to one or more selected Windows. To change all windows, use the All Windows command of the View menu.

To select more than one window at a time, use the standard windows controls: click and drag to select a contiguous range of lines; `SHIFT`-click to select contiguous lines; or `CTRL`-click to select any two or more lines.

Select Windows: Make Visible

Choose this function to open a list box with all hidden (invisible) display windows or display icons contained in the worksheet. To show one or more display window, select them from the list. Press the OK button to accept the selection and leave the dialog box. The selected will be shown as a restored window or an icon, depending on the state that it was in when hidden.

Select Windows: Make Invisible

Use this function to hide one or more display windows or icons. A list of all visible display windows and icons will be listed. To hide one or more display windows or icons, select them from the list, and press OK to accept the selection and leave the dialog box.

Select Windows: Restore

Use this function to open a list box with all visible iconized windows. To restore one or more display windows, select one or more from the list and press the OK button to accept the selection. The selected windows are restored and shown as windows.

Select Windows: Minimize

Choose this function to open a list box with all visible restored display windows. To minimize one or more display windows to an icon, select them from the list and press the OK button to accept the selection. The selected windows are minimized and shown as icons at the bottom of the Windows Desktop.

1.5.7 Window Arrangements

Save Window Arrangement

Choose this function to save the sizes and positions of all the activated display windows and to define an identifying tag for that arrangement.

Use this function to easily switch between different display window arrangements even while an experiment is running. You can save up to 8 different display window setups.

To activate this function,

- Press `ALT+SHIFT+`Arrangement Number (`1-8`) on your keyboard, or
- Choose the Save Window Arrangement command from the View menu.

The Window Arrangement dialog box appears, displaying the Arrangement - Number and Text either of the current setup, or, if you have used the keyboard shortcut, of the setup whose number you have typed after `ALT+SHIFT.`

You can now save the current arrangement under any Arrangement Number from 1 to 8 and add a name or short description of your choice in the Text field. Click

OK, or press ENTER, to complete the procedure. If an arrangement has already been saved under this number, you will be warned.

The name or description you have entered in the Text field appears in the list of window setups on the Function Bar.

⇨ *Choose Select Window Arrangement to re-arrange the display windows in one of the arrangements you have previously saved.*

⇨ *Choose Delete Current Window Arrangement to delete the current setup from the list of saved arrangements.*

Select Window Arrangement

Choose this function to re-arrange the activated display windows on the screen in one of the arrangements you have previously saved. Each of the activated display windows appears in the same position and size as previously saved.

Additional display windows (not contained in the arrangement when it was saved) remain in their positions while the others return to their defined places on the screen.

To activate this function,

- Click on the list box on the Function Bar (or on the down arrow on its right), or
- Press ALT+0 on your keyboard, or
- Choose the Select Window Arrangement command from the View menu.

In the Function Bar list box, the name**tags** of all the saved arrangements are listed. Click on the name of the arrangement that you want to restore, or choose that tag by pressing the arrow keys on your keyboard; then press ENTER.

Using a keyboard shortcut, you can select any of the saved arrangements by pressing ALT+Arrangement Number (1-8).

☝ *If you restore one of the saved window arrangements as described, the sizes and positions of the current display windows will be lost, unless you have saved them under another Arrangement Number.*

☝ *If you delete one of the display modules contained in the saved window arrangement from the worksheet, its display window is permanently removed from the saved arrangement, too. To restore the original setup, you must re-install the display module in the worksheet, and save the display window arrangement again.*

⇨ *Choose Save Window Arrangement to save the current sizes and positions of all the activated display windows.*

⇨ *Choose Delete Current Window Arrangement to delete the current setup from the list of saved arrangements.*

Delete Current Window Arrangement

Choose this function to delete the currently displayed setup of display windows from the list of saved arrangements.

Only the information concerning the sizes and the positions of the display windows are removed; the display windows themselves remain in the worksheet unchanged.

To activate this function, press ALT+CTRL+Arrangement Number (1-8) on your keyboard, or choose the Delete current Window Arrangement command from the View menu. You will be asked to confirm your decision before the information is actually deleted.

⇨ *Choose Save Window Arrangement to save the current sizes and positions of all the activated display windows.*

⇨ *Choose Select Window Arrangement to re-arrange the display windows in one of the ways you have saved before.*

1.6. Options Menu

The commands of this menu allow you to change the display of the ***ServiceLab*** worksheet and to switch the Autorouter function on and off.

Global Setup…

Directories…

Default Fonts…

Colors…

Autorouter

Password Protection…

Password Definition

Screen Locking

Key Events…

List of Actions

Overview of Actions

Define Global Strings…

Define Global Variables…

Copy Channel Names

Switch to Runtime

1.6.1 Global Setup…

*Choose this command to change the **ServiceLab** screen settings and program start options.*

⇨ *The settings are automatically saved when you exit **ServiceLab**. The same window setup will be used the next time **ServiceLab** is started. These settings are **not** saved with the worksheet when you choose the Save or Save As... commands from the File menu.*

Window Type

Select this option to place a background grid on the worksheet.

Type of Grid

- Dots The grid intersections will be marked by dots.
- Lines A complete grid will be displayed.

Spacing

Choose a value between 8 and 48 points to specify the minimum distance between the module symbols in the work area and to specify the size of the screen grid.

After setting the spacing, new modules will be placed using this setting. When the spacing value is changed, it will not affect the layout of existing modules on the worksheet. When you move a module, it will be positioned using the new settings.

⇨ *The spacing value should be at least 16 points, to ensure that there is enough space for data channels between the module symbols.*

Start Options

- By default, ***ServiceLab*** copyright information is displayed at program start. In the Show Copyright Information box you can choose if you wish this information to be displayed each time or not.
- When you open a worksheet, the Module Bar settings that were saved with it will be loaded, possibly modifying the current Module Bar settings that you'd rather maintain.
  - Activate the Load Module Bar with Flow Chart box if the current Module Bar configuration is to be replaced with the new one from the worksheet file.
  - Deactivate this box if you wish to retain the current Module Bar configuration whenever you open a worksheet file.

Common Options

- Choose Open dialog box when Module is created to automatically open the module properties dialog box when the module is added to the worksheet.

- Choose Show File Information with Flow Chart to display the **File Info** each time the experiment starts.
- Choose Show Warning if Data Stream stops to cause the program to display a message if one module isn't able to process the incoming stream of data.
- In all write data operations, the Create Directory if Necessary option causes ***ServiceLab*** to create the named directory when it does not exist

  Example:

  Bad entry in Edit field:

  Default Directory: C:***SERVICELAB***\DATA
  New Directory: C:\ ***SERVICELAB***\DATA\

  Correct entry in Edit field:

  Default Directory: C:***SERVICELAB***\DATA
  New Directory: C:***SERVICELAB***\DATA\${STRING_001}

  Where `{STRING_001}` contains the advanced path and file name, such as <`NEW-DIR\FILE1`>.

  The full path of the newly created directory and file will be: `C:\`***SERVICELAB***`\DATA\NEW-DIR\FILE1.DDF`

  For example, creating new directories is useful when writing files into subdirectories with a time stamp, such as creating day, month or year to store the files into them using an event driven action.

  To create the time stamp, don't use the global string `${DATE}`, because the punctuation marks (dots) in this string may be incompatible with the Windows file structure. Instead, combine the `${DAY}-${MONTH}-${YEAR}` strings and use another punctuation mark.
- The Hide Flowchart Load Progress Bar option turns off the progress bar when the elements of the worksheet are loaded.
- Choose Create Module via Drag & Drop to insert new modules onto your selected location on the worksheet under user control. The modules are not inserted at default places, but ***ServiceLab*** first shows an insert cursor to allow you select the position the new module will be placed.
- If the Release CPU time if idle Option is active ***ServiceLab*** releases the reserved CPU time to other programs

Start/Stop Options

- If the Save Backup Flow Chart setting is active, the current worksheet is saved under the file name LAST.DSB when the ***ServiceLab*** worksheet is started.
- The Copy Channel Names at Start of Experiment option enables or disables the ***ServiceLab*** default setting to Copy The Channel Names of the connected modules into newly connected modules

- The Switch to Displays at Start of Experiment option allows you to specify that the Worksheet view will be hidden, and the Display Window view will be activated when the experiment starts.
- The Switch to Worksheet at Stop of Experiment option allows you to specify that the Worksheet view will be restored when the experiment stops.

1.6.2 Default Directories

Use this menu item to set and modify the locations of drives and directories that ***ServiceLab*** uses by default for loading or saving files. Different directories can be set up for various file types.

When you select this menu item, a dialog box is opened, displaying each file type with the currently valid directory. Clicking on the respective switches can change the setup.

Default drives and default directories can be specified for the following file types:

Item	**File type**
Worksheet	***ServiceLab*** worksheet files (extension ∗.DSB)
Streaming	data files for fast disk streaming
Data	data files of the Write Data module
Devices	configuration files for the serial interface and the IEEE interface
Other	Module Bar, Interpolation and other files

By clicking on a switch a dialog window opens allowing the selection of a drive and a directory. New directories can also be created here.

The drives and directories specified here are only used as defaults. If a file name must be assigned while working with ***ServiceLab,*** these pre-set locations are shown in the input window for the respective file type. If required, a different drive and directory can be selected.

After the initial installation, the ***ServiceLab*** installation directory is used for all default settings.

The settings made here are saved in the ***SERVICELAB***.INI file in the Windows directory.

1.6.3 Fonts

This option allows you to define the module display windows font style and size. Choose from the following **4** options:

- One Font, Fixed Size

  If this option is used, all text elements of the display windows use the same type of fonts. The size is fixed and is always used even if the dis-

play window is stretched or compressed. Use the Font... button to select type and size.

- One Font, Variable Size

  If this option is used, all text elements of the display windows use the same type of fonts, but the size is adapted to the proportions of the text areas of the display window if the window is stretched or compressed.

- Variable Font, Fixed Size

  This setting allows you to select several types of fonts for the elements of the display window. Use the buttons on the bottom of the dialog box to select individual font styles and sizes for these elements. The selected fonts size is always used even if the display window is stretched or compressed.

- Variable Font, Variable Size

  This setting allows you to select several types of fonts for the elements of the display window. Use the buttons on the bottom of the dialog box to select individual font styles for these elements. The size of fonts is adapted to the proportions of the text areas of the display window if the window is stretched or compressed.

⇨ *The buttons to select the different text elements in display windows depend on the kind of display window module. For example the buttons names for the Digital Display module are Channel Name..., Value... and Scale..., or while the Status Lamp module only shows Channel Name... and Status text....*

⇨ *If you activate these functions from the* Options *menu, the setting is applied to all newly created modules on the worksheet; but existing modules are not affected. You can change this default setting by opening the individual text dialog box of the modules.*

- Apply Button

  Use this button to change the font of all text elements to the chosen default type. All existing modules are changed.

1.6.4 Colors

*Use this command to choose the colors for the **ServiceLab** worksheet display. You can specify colors for the background, the grid and the data channels wire core and sleeve.*

⇨ *The settings are automatically saved with information about the window size and position when you exit **ServiceLab**. The settings are not saved with the worksheet when you choose the Save or Save As... commands from the File menu.*

Standard Colors

- Select the item you want to change. The Windows color selection dialog box appears.
- Click on the color of your choice in the Standard Colors palette using the **left** mouse button.
- If you prefer to create your own custom color, click Edit Colors.

Edit Colors

You can create custom colors for the background, the grid and the data channels, wire cores and sleeves.

- Select the item you want to change. The Windows color selection dialog box appears.
- Click on the color you want to edit using the **left** mouse button.
- Choose Edit Colors.
- To increase or decrease the amount of primary color, brightness and/or saturation used in a color, drag the crosshairs and/or the vertical scroll bar keeping the **left** mouse button depressed.

  You can also type numbers from 0 to 255 in the corresponding boxes. The resulting color is displayed in the Custom box.

  To reset all the values for the standard color that comes nearest to the custom color you have just defined, double-click the Standard box.
- Choose the OK button to change the color of the selected screen element to the custom color.
- To save the custom color you have defined:
  - Click any of the boxes in the Custom Colors palette first.
  - Then modify its color as described above.
  - Click Add Color to Palette.
  - Specify further colors from the Custom Colors palette and modify them.
  - Choose the OK button to change the color of the selected screen element to the custom color.
  - To return to the color originally displayed on the screen, choose the Cancel button.

1.6.5 Autorouter

Choose this option to switch the Autorouter function on or off. A check mark (✓) indicates this function has been activated.

When the Autorouter is active, ***ServiceLab*** automatically finds the correct paths for your data channels. ***ServiceLab*** ensures that the data channels do not run

across modules or hide other data channels. The Status Bar displays the progress of the autorouting operation.

When the Autorouter is not active, you can determine the paths of your data channels.

⇨ *The Autorouter function **cannot** automatically rearrange existing data channels to take the shortest or most direct way between modules. You must manually rearrange a data channel or move a junction point to a different position to improve the clarity of your worksheet structure.*

1.6.6 Password Protection/Password Definition

Use a password to protect a worksheet against unauthorized use or modification. A check mark (✓) indicates that this function is active.

Password protection is activated by

- Clicking the Password Protection command,
- Specifying the password itself by using the Password Definition command,
- And then saving the worksheet.

Password protection applies to the entire worksheet. Black Boxes may also be protected via Passwords. The settings are made in an active Black Box in the Edit: Black Box Properties.

If Password Protection is activated without entering a password at the same time, you will be prompted to specify the password when the worksheet is saved.

Once Password Protection has been activated and the worksheet has been stored, it can only be opened again by entering the correct password.

This function is only relevant when you save a worksheet or use the Screen Locking function. It does not affect any other function or module.

⇨ *If you have forgotten or do not know the password of a worksheet, you will **not be able to open the worksheet**. Take this into consideration when you choose a password, and take adequate precautions so that you will always remember your passwords.*

A password must contain at least 4 and up to 10 alphanumeric characters. If the number of entered characters is less than 4, a warning message will appear when you close the dialog box.

For security reasons, the password must be entered twice. If the two passwords are not identical, you must reenter the password.

While you type the password, the characters are not echoed, but appear as asterisks (∗). Password recognition is case-sensitive; the same combination of upper and lower case characters must be specified.

A correctly entered password is valid

- Until you exit ***ServiceLab***, or
- Until a different password is entered, or
- Until you open a different worksheet requiring a different password, and you enter that new password correctly.

1.6.7 Screen Locking

*Activate **Screen Locking** to disable all keyboard and mouse inputs after starting measurement.*

To unlock, use the ESC key. If Password Protection is active, the password will be requested. You must enter the correct password to Unlock.

Screen locking also can be activated and deactivated via Event Driven Actions.

When Screen Locking is activated, Key Events, as defined in the Options Menu, **are** available.

1.6.8 Key Events

Use Key Combinations to cause actions on the worksheet.

It is possible to cause all Actions of modules that are used in a worksheet by using an Action module or using key or key combination (1 or 2 Special key + one normal key for example CTRL+SHIFT+S).

Select the option menu command key events. If the Show Window with defined Key Events switch is set, the window shows all defined key actions. You can hide single key events in the dialog box define key events

The New button opens a key events dialog box where you can define parameters used by the key actions.

To change existing Key Events, choose the line and click the Change button. The dialog box will show the active parameters. Click in the parameter field to change them.

The Delete button deletes selected key action.

The Reset button deletes **all** defined key events.

To use Key Events you need:

- The key or key combination,
- The Receiver for the action,
- The Action itself and
- The Action-dependent Parameters

Receiver

The Receiver entry specifies the module that is to execute the initiated action.

- In the Module pull-down list box, all the modules in the worksheet (which can perform actions) are listed together with the ***ServiceLab*** main window.
- Use Channel to specify which channel(s) of the selected module is to perform the actions. Individual channels can be separated with spaces or commas. Channel groups are entered with hyphens.

Example: To use the channels 1, 3, 7 and 9 up to 12 of the Receiver module for the event, enter: `1 3 7 9–12` or `1,3,7,9–12.`

This setting does not influence actions relating to the entire module.

Parameters

You can define Parameter values to be used by the action (Worksheet name, Layout number, Global String, etc.).

Screen Lock mode

You can allow key events while Screen Locking is active. The default setting is Do Not Execute Action.

Description

While the Show Window With Defined Key Events option is active, key actions will be displayed in an overview window. The default is Display. You can insert a descriptive text string in the entry field that will be shown in the window. If the string is empty, the Action text will be displayed.

1.6.9 List of Actions

The List Actions ... item opens a dialog box that allows you to copy a description of any actions and their parameters, as defined in the worksheet, into the clipboard or to store it into a text file.

You can select one of the defined action modules from the list window. The parameters of the selected action module are shown in the display area.

You can also select one of the actions defined in the selected module. The parameters of the selected action are shown at Event Parameter, Receiver Channel and Parameter of action (Number, Value).

Buttons

- Copy: This button opens a dialog box to copy the data into the clipboard. You can select whether the parameters of the selected or all defined action modules are copied. Click on OK to start the copy.
- Save: This button opens a dialog box to save the data into a text file. You can select whether the parameters of the selected or all defined action

modules are stored. The File name button opens the file menu to select/create the file the data become stored. Click on OK to start saving data.

The text file has the following format:

```
Module name:   Action00
Channel:       0
Channel name:  Action 0
Event:         Rising Edge
Receiver:      <SERVICELAB>
Receiver Channels:   All Channels
Action:        Activate Layout
Layout:        1
Asynchronous action

Channel:       1
Channel name:  Action 1
Event:         Falling Edge
Receiver:      Generator00
Receiver Channels:   All Channels
Action:        Change Amplitude
To:            2,0000
Asynchronous action
               ...
Module name:   Action01
Channel:       0
Channel name:  Action 0
Event:         Rising Edge
Receiver:      <SERVICELAB>
Receiver Channels:   All Channels
Action:        Activate Layout
Layout:        2
Asynchronous action
And so on.
```

1.6.10 Overview of Actions

The Overview of Actions… command opens a list box, showing all Event Driven Actions defined in the actual flowchart.

The four columns show the name of the action module, the defined condition, and the event such as the receiver of the action. You can choose each of these four items to be displayed in each column. The entries in the list will be ordered alphabetically.

- Copy: This button opens a dialog box to copy the data into the clipboard. You can select whether the data of the selected or all defined actions are copied.

- OK button starts copying the information
- Save: This button opens a dialog box to save the data into a text file. You can select whether the parameters of the selected or all defined actions are stored.
- File Name opens the file menu to select/create the file where the data will be stored.
- OK button starts saving data.

To get more detailed information about the defined actions you can use the List of Actions... command. There you can select each action module defined in worksheet and display all of its settings and parameters.

1.6.11 Define Global Strings

Global Strings allow you to define and modify ASCII text strings used in ***ServiceLab*** while a measurement is running. You can pass text strings to ***ServiceLab*** worksheets running in succession (See the Working Example below). You can define up to 999 Global Strings. When the measurement is running a Global String can be defined or modified using the menu command Define Global Strings. Defined strings are stored with the worksheet.

You can display Global Strings as text objects in Layout Windows. Use the placeholder ${STRING_xxx} in the line text object. Replace xxx with the number of the string.

Several System/Program Information strings and variables (such as Free Memory, System Resources, Author, Company, etc.) are implemented in ***ServiceLab*** as fixed placeholder strings/variables. If an Edit field will accept placeholders, right mouse click in the Edit field to open a Popup menu with the Global Strings displayed as a menu item. This Item opens a list with all available strings. Double-Click on the requested placeholder to insert it into the Edit field

You can use the RS232 Input module to receive strings instead of measurement values and then assign them to a Global String.

Optionally, you can to load a Global String after starting a worksheet or save a string into the ***SERVICELAB***.INI file when you stop. Other applications are able to modify strings via DDE. And, you can define, load or save a Global String using Event Driven Actions or key events.

Each Global String consists of a number, text (max. 255 char.) and options. The Reset button sets all strings in the list to the default settings. The Reset all button deletes all strings.

You can select and modify more than one string simultaneously using the `SHIFT` and `CTRL` keys to select the strings.

You can define the following Options to handle Global Strings:

- Read from INI file at start of experiment
- Write to INI file at stop of experiment
- No DDE access to Global String

- Write to data file (DASYTEC **or ASCII)** Header
- Show Global String in window
- Type In at start of experiment
- Input is required to close dialog box
- File Name Dialog

You can also define a short description.

Extended…

Click on the Extended button to make additional settings for Global Strings.

- Name: You can define a name to be used with variables and strings. You can refer to the String/Variable using the defined name: ${NAME} or by its number {$VAR_xxx} or {$STRxxx}.
- Expressions: If the Calculate Expression automatically option is activated you can define a mathematical expression similar to the Formula Interpreter. The expression is allocated to the variable or string. If one of the parts in the expression is changed, the variable or string is automatically recalculated.

Each expression is a special type of data (numeric <variable> or alphanumeric <string>). You only can link string expressions with strings and numerical expressions with variables; otherwise the program generates an error message.

The numerical expressions are the same as in the Formula Interpreter.

Mathematical functions:

+	Addition	-	Subtraction
*	Multiplication	/	Division
>	greater	<	less than
>=	greater than or equal	<=	less than or equal
=	equal	<>	not equal
^	raise to a power	MOD	Modulo remainder of Division operation
OR	logical OR	XOR	logical XOR
AND	logical AND	NOT	logical NOT

Trigonometric functions:

sin	Sine	sinh	Hyperbolic Sine
arcsin	ArcSine	cos	Cosine
cosh	Hyperbolic Cosine	arccos	Arc Cosine
tan	Tangent	tanh	Hyperbolic Tangent

arctan	ArcTangent	sqr	Square
sqrt	Square root	frac	Fractions
trunc	Truncate	round	Round
abs	Absolute value	rand	Pseudo random function
exp	Exponential function	ln	Logarithm, base e
log	Logarithm, base ten	sign	Sign

String functions: Relational Operators

+	Link/concatenate		
>	Greater than	<	Less than
>=	Greater or equal	<=	Less than or equal
=	Equal	<>	Not equal

Results are: true=1; false=0

⇨ *For comparison operations with strings, the characters of the strings are weighted corresponding to the value in the ASCII Table, shown in the ASCII Table on page C-1. The strings are checked character by character and sorted by priority.*

Additional String Operations

Operation	Parameter	Description
strlen	(String)	Length of strings (numerical result)
strind	(String, Search-string)	Position of the search-string in a string (numerical result)
strval	(String)	String-value, Numerical value of the strings.
substr	(String, Start, Length)	Substring, Result is a substring with defined length and start position (Start and Length are numerical and also may be expressions!).
upper	(String)	Convert characters of string to upper case
lower	(String)	Convert characters of string to lower case
strsel	(Condition, TrueString, FalseString)	Select string depending on a special condition

Constants

PI	Pi (π)	e	e function
True	Is true (=1)	False	Is false (=0)

(	Open parenthesis	)	Close parenthesis

Priority of Strings

	Sort =>	1st Step	2nd Step = Result
sand	Position 1	Sand(1)	SAND(1.1)
Sand	Position 2	SAND(1)	Sand(1.2)
sAnd	Position 3	sand(2)	sAnd(2.1)
SAND	Position 4	sAnd(2)	sand(2.2)

SAND > Sand > sAnd > sand

	Sort =>	1st Step	2nd Step	3rd Step	4th Step = Result
Sund	Position 1	Sund(1)	Sand(1.1)	Sand(1.1.1)	Sand(1.1.1.1)
sOnd	Position 2	Sand(1)	Sund(1.2)	Sund(1.2.1)	Sund(1.2.1.1)
Sand	Position 3	sOnd(2)	sOnd(2.1)	sOnd(2.1.1)	sOna(2.1.1.1)
sOna	Position 4	sOna(2)	sOna(2.1)	sOna(2.1.1)	sOnd(2.1.1.2)

Sand > Sund > sOna > sOnd

Characters that influence the sort are bold! The priority after each step is shown in the brackets. If all strings have a different priority, the operation is aborted because the resulting step is reached.

Value of Strings

The string has to start with a numerical character or decimal point (point or comma); otherwise the string value is 0. Leading blanks are ignored. If there is a blank within a numerical string it is interpreted as an alphanumerical character. Any following numerical characters are lost.

String	Value	String	Value
1.0	1	,2	0,2
1,05	1,05	12, 35 EUR	12
1 EUR	1	1EUR 95 Cent	1
3,045.23	3,045	EUR 1,05	0

Global Strings used in Modules

Most modules can process Global Strings. ***ServiceLab*** is constantly improving, and adding places where you can use Global Strings. One way to determine if a parameter box permits a Global String is to right click in the parameter box. If the popup menu shows Global String… then you can use a string successfully in that location.

Predefined Global Strings

The global strings in the following list are predefined and are offered in selection list for quick insert:

Strings with System Information:

String	Description
${DATE}	Current Date
${TIME}	Current Time
${DAY}	Day of current date (numeric, 1-31)
${MONTH}	Month of current date (numeric, 1-12)
${YEAR}	Year of current date (e.g. 2001)
${HOUR}	Hour of current time
${MINUTE}	Minute of current time
${SECOND}	Second of current time
${DAY_LZ}	Current day with leading zero (e.g. 07)
${MONTH_LZ)	Current month with leading zero
${YEAR_2)	Current year with last two digits (e.g. 01)

Worksheet specific Strings

String	Description
${FLOWCHART}	Name of Flowchart without path
${FULL_FLOWCHART)	Name of Flowchart with full path
${CREATION_DATE}	Date of Worksheet Creation
${CREATION_TIME}	Time of Worksheet Creation
${MODIFY_DATE}	Date when Worksheet was last changed
${MODIFY_TIME}	Time when Worksheet was last changed
${START_DATE}	Measurement Start Date
${START_TIME}	Measurement Start Time
${AUTHOR}	Author, as defined in DASYTEC File Info
${COMPANY}	Company, as defined in DASYTEC File Info
${DEPARTMENT}	Department, as defined in DASYTEC File Info
${TITLE}	Title, as defined in DASYTEC File Info
${DRIVER_MESSAGE}	Driver specific message

1.6.12 Define Global Variables

You can define and modify Global Variables while a measurement is running. You can pass variables to subsequent worksheets running in succession (see the Working Example below). You can define up to 999 Global Variables. When the measurement is running a Global Variable can be defined or modified using the menu command Define Global Variables.

⇨ *Defined variables are stored with the worksheet.*

Optionally, you can load a Global Variable after starting a worksheet or save a variable into the `SERVICELAB.INI` file when you stop. Other applications are able to modify variables via DDE. And you can define, load or save a Global Variable using Event Driven Actions or Key Events. You can display Global Variable as text objects in Layout Windows. Use the placeholder ${VAR_xxx} in the line text object. Replace xxx with the number of the variable.

Several System/Program Information strings and variables (such as Free Memory, System Resources, etc. /Author, Company, etc.) are implemented in ***ServiceLab*** as fixed placeholder strings/variables. If an Edit field will accept placeholders, right mouse click in the Edit field to open a Popup menu with the additional menu item Global Variable.... This Item opens a list with all available variables. Double-Click on the requested placeholder to insert it into the Edit field

⇨ *Use the Action module to save the variable to the INI file while the experiment is running*

Each Global Variable is composed of a number, numerical value (max. 255 char.) and one or more Options. The Reset button sets all variables in the list to the default settings. The Reset all button deletes all variables.

You can select and modify more than one variable simultaneously using the mouse to select a range, using the `SHIFT` key to select a contiguous range and the `CTRL` key to select non-contiguous variables.

You can define the following Options to handle Global Variables.

- Read from INI file at start of experiment
- Write to INI file at stop of experiment
- No DDE access to Global Variable
- Write to DASYTEC Header
- Show Global Variable in window
- Type In at start of experiment

You can also define a short description.

Extended…

Click on the extended button to make additional settings for Global Strings.

- Name: You can define a name to be used with variables and strings. You can refer to the String/Variable using the defined name: ${NAME} or by its number {$VAR_xxx} or {$STRxxx}.
- Expressions: If the Calculate Expression automatically option is activated you can define a mathematical expression similar to the Formula Interpreter. The expression is allocated to the variable or string. If one of the parts in the expression is changed, the variable or string is automatically recalculated.
- The settings made in the Extended**…** dialog box are not permanent until the main Define Global Variables... dialog is closed using the OK Button**.**
- See Define Global Strings Extended… on page 4-54 for details of the settings and features.

Global Variables used in Modules

The following list shows you the modules that can process Global Strings. ***ServiceLab*** is constantly improving, and adding places where you can use Global Variables. One way to determine if a parameter box permits a Global Variable is to right click in the parameter box. If the short menu shows Global Variable… then you can use a variable successfully in that location.

Predefined Global Variables

The global variables in the following list are predefined and are offered in the selection list for quick insert:

Variables with system information:

Variable	Description
${SYS_RES}	Free System Resources: This variable shows the load of the Windows system resources. If the value decreases (in %), the load increases.
${GDI_RES}	Free GDI Resources: This variable shows the load of the resources of the Windows Graphic Device Interface. If the value decreases (in %), the load increases.
${USER_RES}	Free User Resources: This variable shows the load of the Windows user resources. If the value decreases (in %), the load increases.
ACTUAL_YEAR}	Actual Year: shows actual year as numerical value, shown in 4-digit format (yyyy).
${ACTUAL_MONTH}	Actual Month: shows actual month as numerical value.
${ACTUAL_DAY}	Actual Day: shows the actual day as numerical

	values.
${ACTUAL_HOUR}	Actual Hour: shows the actual hour as numerical values.
${ACTUAL_MINUTE}	Actual Minute: These Variables show the actual time (Year, Month, Day, Hour, Minute or Second) as numerical values.
${ACTUAL_SECOND}	Actual Second: actual time (Second) as numerical value.
${WEEK_DAY}	Actual Day of the week: This Variable shows the day of the week as numerical value. The order starts with Sunday (value=0) end ends with Saturday (value=6).

ServiceLab / Worksheet specific Variables

Variable	Description
${BLOCK_SIZE}	Global Block Size: This value shows the preset global block size
${SAMPLE_RATE}	Sampling Rate: This value shows the preset global sampling rate
${TOTAL_LOAD}	Total Program Load in percent: This variable shows the loading of the data acquisition program. Values of 100% and higher are displayed if the program is fully loaded or overloaded. In this case, it threatens to interrupt the running measurement by the program. To reduce the load, decrease the sampling rate, increase the block size, disable the animation and so on. The displayed value isn’t very precisely calculated because the time base used is 55 msec. So fluctuations in display are normal.
${TOTAL_DELAY}	Total Program Load in milliseconds Time delay shows the time a sample needs to pass all modules in worksheet. This may give an impression of the processing time that is needed to perform all operations defined by the function modules. The displayed value isn’t very precisely calculated because the time base used is 55 msec. Fluctuations in the display are normal.
${USED_BUFFER}	Used Driver Buffer: This value (in %) shows the usage of the driver buffer of the program. If the buffer is completely filled (100%), the measure-

ment stops with an error message ***Sampling rate too high***.

First check your flowchart and optimize it as much as possible (see also Tips & Tricks in the User Guide). Then check the buffer settings in Experiment setup and increase if possible. Also check whether other applications are running in the background, which may delay data processing in the program. Decrease the sampling rate and/or increase the block size.

${DAPx_FREE_MEM}	Free Memory on DAP Boards x (x=1 ... 8): This value (in %) shows the usage of the driver buffer of the Microstar DAP board. If the buffer is completely filled (100%), the measurement stops with an error message ***Sampling rate too high***. First check your flowchart and optimize it as much as possible (see also Tips & Tricks in the User Guide). Also check whether other applications are running in the background, which may delay data processing in the program. Decrease the sampling rate and/or increase the block size.
${DRV_DATA_LOST}	Driver specific: shows the number of values lost in the driver since the start of measurement. May indicate performance problems with the driver's ability to capture data at the specified sampling rate.
${ELAPSED_TIME}	Elapsed time of measurement in seconds from the start of measurement

Options for Global Strings and Variables

Read from INI File at start of experiment

If this option is chosen, entries in the INI file will be read and imported as actual settings. ***ServiceLab*** will start the experiment with these Global Strings and Variables.

Write to INI File at stop of experiment

If this option is chosen, all defined Variables or Strings are written to the INI file when the experiment stops. These Global Strings/Variables are available in INI File the next time you start the experiment.

No DDE access to Global String/Variable

If this option is chosen, there is no DDE access to Variables or Strings. The Default setting is DDE access allowed.

Write to DASYTEC Header

When this option is chosen, this Variable/String is written into the file header when you save data using the DASYTEC or ASCII format file formats. When using the ASCII format you must define whether the strings/variables should be written as readable entries or just as information in the Write Data module. This information can be read back using the Read Data module.

⇨ *If Take variables or Take strings option in the Read Data module is active, previously defined strings or variables will be overwritten.*

Type In at Start Of Experiment

When this option is chosen, a dialog box will open when the experiment starts. All defined Strings or Variables are listed in the input area. Up to 10 Strings and Variables are displayed on each page. If there are more than 10 entries, you can select the next page. You can change each String or Variable before starting measurement.

If the Read from INI File at start of experiment option is also chosen, all entries in the INI file are read and displayed in the dialog box.

Click the Start button to start measurement with the defined parameters. If you choose Cancel, measurement will not start and the program will switch to the ***ServiceLab*** worksheet window.

To change the order of the Variables/Strings shown in the startup dialog box, use the Design Startup Dialog command in the Options menu.

Show Global String/Variable in Window

Choose this option to open a display window showing the contents of selected Global Strings and Global Strings. The display will update when the values change. The description and the contents are displayed, but not the number of the Variable or String. Use this option to display the current file name when the File Name -> Global String option is selected in the Read Data or Write Data modules.

Input is required to close dialog box

With this option activated, the input dialog box will not close unless at least one character is entered into the entry field. This option affects the input of global strings at start of measurement or using event driven actions.

File Name Dialog

Select this option to specify that the string will be used as a file name. At the start of the experiment or via an Event Driven Action, an Explorer window will be opened to select an existing file name. Double click on the file name to copy it directly into the string window. In the Pull down window you can select the type of file to be loaded. Choose whether the selected file will be used to load data (Read Data) or to write it (Write Data).

Working Examples of Global Strings and Variables

Global Strings and Global Strings are useful in several modules. To use Global Strings, an identifier ${STR_xxx} is inserted into an arbitrary alphanumeric string, where xxx is a numeric character from 1 to 999 (${STR_0001} to ${STR_999}). Spelling is not case sensitive. You cannot have blanks between the $ character and the curly bracket. Terms that are not recognized return an empty string. Global Strings are specified by the identifier ${VAR_0001} to ${VAR_999}. ***ServiceLab*** automatically recognizes whether it should be used as text or as a numerical value. The preset format is used for text. Maximum number of characters in Strings or Variables is 256.

To manipulate Global Strings or variables via DDE, there are 4 new DDE items available to the **Menu** topic**:** `SetGlobalString`, `GetGlobalString`, `SetGlobalVar` and `GetGlobalVar`. With both Get functions, only the number is transferred as an ASCII value (in which case ***ServiceLab*** acts as a DDE Server. The connection is a Cold Link). The result is sent back by ***ServiceLab*** as an ASCII value. When there is no result (wrong number, etc.) ***ServiceLab*** answers with a string containing “Parameter Error.” To set Strings or Variables (***ServiceLab*** acts as a DDE Server. Connection has to be a DDE Poke) the number and the defined character string or the numerical value is sent separated by a semicolon. ***ServiceLab*** doesn’t send an answer message.

Input strings/variables using actions

The Action Module has two global (***ServiceLab***) actions: Set Variable and Set String which allow you to enter strings and variables. In the Action Module parameter settings you can define any string that will then be displayed as the title of the input window.

These entries are only accepted if each global string With Input Required **...** contains at least one character.

To access the variable/string **No 1,** the entry in channel 1 has to be **0**, for **No 2** use **1**, in **No 3** use **2** and so on. Only **first 16** variables or strings can be accessed (channel = 0 ... 15)

Automatic Creation of directories with time stamp

To store data files automatically into separate directories with names containing the actual month and day in their name, and with the hour of storing in the file name, use the following entry in the Write Data module:

C:***SERVICELAB***\DATA\${MONTH}-${DAY}\${HOUR}h

Additionally, the worksheet has to contain an Action module with the Close/open worksheet action with the Global String has changed event on two channels. The event parameter for the first channel is the `${DAY}` string and on the second it is the `${HOUR}` string. On the third channel, the Save Data action must be initialized on the `${HOUR}` event.

After measurement has started the following actions will happen: (Starting date and time of measurement: May, 28th, 1998, 13:30)

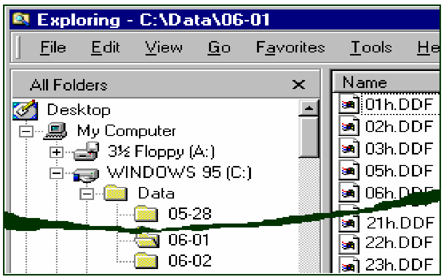
Reaching the next full hour, a new directory

C:*SERVICELAB*\DATA\05-28 is created and the file **14h.ddf** is stored in that directory.

When starting the next full hour, a new the file **15h.ddf** is written into the same directory and so on, until midnight is reached.

Now the new sub-directory **05-29** is created in **..\DATA** and the first file **00h.ddf**. Until the next change of date is reached, each hour a new file is written into the sub-directory.

This cycle repeats until measurement stops. The following file structure is created:



1.6.13 Export and Import Global Strings and Variables

Use this menu commands to export or import **all** Global **Variables and Strings** into or from a file with the extension *.VAR. This feature allows you to exchange the of Global Strings and Variables settings between several worksheets.

This file format is binary, so you cannot edit it directly.

In addition to the *.VAR file format (generated by the Global Variable Export function) you can now select the *.CSV and *.TXT (Excel format) file formats. To import an Excel table the values need to be separated by a comma. The entries to configure the global variables are (Strings are not valid.):

Col 1	,	Col 2	,	Col 3	,	Col 4	,	Col 5	,	Col 6	,	Col 7
Num-ber	,	Nam e	,	Descrip-tion	,	No. Chars	,	No. digits	,	Value	,	Expres-sion

In this way you can configure the global variables in an Excel table. It is very easy to use Copy and Paste functions to create similar configurations. You must use caution to ensure that you do not enter the same entries several times into the global variable dialog box.

Blanks at the beginning and end of the entries are removed. If the entry is longer than the maximum length (name 19, description 23, and expression 255), it is truncated.

If errors in are found when the file is read (for example, if the name contains a reserved character, VarNumber is out of range, the expression is not defined, etc.) then the offending entry is ignored. If the Expression field is empty then no expression is defined for the variable.

You cannot import Variables/Strings while the worksheet is running.

1.6.14 Design Startup Dialog

Use this command to configure the order of the dialog box that is displayed when the program starts. All Strings/Variables with the Type in at Start of Experiment option activated are listed in the dialog box. Only the Short description is displayed (not the String/Variable number.) If there is no description the line is empty, but is still available. Use the mouse or the cursor keys to select an entry. Use the arrow button to move the selected line up or down. When the experiment starts the next time, the Startup dialog shows the Variables/Strings in the new order.

If you disable the Type in at Start of Experiment option for one or several Variables/Strings, the entries are removed from the list and the following items move up to the next free position. If you subsequently re-enable the option, the Variables/Strings are re-inserted at the first line of the list.

1.6.15 Copy Channel Names

This function causes ***ServiceLab*** to copy the channel names from each module to connected modules. By default, the option is activated in the module dialog box

1.6.16 Switch to Runtime

Choose this function or click on the icon on the function bar, to reduce the ***ServiceLab*** worksheet window to its Runtime size. In its place, a minimized control panel appears which contains only the status bar (displaying the current time and the buffer status) and the control icons from the function bar which allow you to start, stop, pause and continue the experiment.

Additionally, all active display windows (analog/digital meters, scopes etc.) are displayed on screen**.**

This option allows you to determine how your worksheet will appear when loaded with the ***ServiceLab*** Runtime version; you can concentrate on those elements that are essential for the control and evaluation of the actual experiment.

1.7. Window Menu

Use the commands of this menu to switch between Worksheet, Display and Layout windows or to create new VITool Layout pages.

New Layout

Control Sequencer

Display Windows

Worksheet

Layout

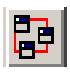
ServiceLab lists the names of all created windows, starting with the display and followed by name of the worksheet. Then all Layout windows are listed. Click on the name to activate a window. The Menu Bar will change depending on the type of the activated window (Control Sequencer, Display, Worksheet or Layout).

You can also switch between display modes by clicking on the function bar icon.

1.7.1 New Layout

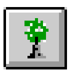
Use this command to create a new Layout Window. The name of worksheet and the first nine Layout Windows are displayed below the menu commands. If there are more than ten windows you can use the More command to see them.

1.7.2 Control Sequencer



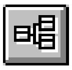
Use this command or click on the function bar icon to switch to the Control Sequencer View.

1.7.3 Display Windows



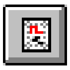
Use this command or click on the function bar icon to switch to the Display Tree View

1.7.4 Layout



Use this command, or click on the function bar icon, to switch to the Layout View

1.7.5 Worksheet



Use this command, or click on the function bar icon, to switch to the Worksheet View.

2. Control Sequencer Menus

The commands of the Control Sequencer File menu enable you to save and open Control Sequence files, to print worksheets, to manage your worksheet files, and to exit the program.

Control Sequencer File

To control a multi-step application consisting of more than one ***ServiceLab*** worksheets calling each other, ***ServiceLab*** offers a new tool, shown as new display window (analogous to the worksheet, display and VITool windows), called the Control Sequencer Window. The contents of the window is stored in a new type of file, the Control Sequencer file (saved with the suffix ***.DSQ**.)

The window shows a **tree display** of the **control sequence**. You can add any number of worksheets into the Control Sequencer File, whose name is shown as root of the tree.

You can also multiple actions for each inserted worksheet to control the flow of the worksheets.

In the Control Sequencer window you can load and save *.DSQ files using the main menu file commands: **New**, Open, **Save** and **Save As…**.

To insert flowcharts or actions you need to use the pop-up context menu that appears when you right mouse click on one of the junction points on the screen. Depending on the junction (flowchart or action) the pop-up menu offers several commands to add, delete or to edit the object.

The Sequence file is a binary file type. You cannot edit it with ASCII Editor programs such as Notepad.

2.1. File Menu

See Worksheet Window Menu: File Menu (page 4-1).

2.1.1 New

Choose this command to create a **new** Control Sequence file. The ***ServiceLab*** Control Sequencer work area will be cleared completely.

If there is already a Control Sequencer file loaded on the screen that has changed since you last saved it, you will be asked to

- save that file before beginning work on the new one,
- or to reject those changes,
- or to recall the New command.

After creating the new Control Sequencer file you can save it to a file by selecting the Save or the Save As... commands from the **File** menu.

Click on the Save icon in the function bar to save the current file.

2.1.2 Open...

Choose the Open command, or click the function bar icon, to open a Control Sequence file that has been previously saved. The ***ServiceLab*** Control Sequence work area will be cleared completely.

If there is already a Control Sequencer file loaded on the screen that has changed since you last saved it, you will be asked to

- save that file before beginning work on the new one,
- or to reject those changes,
- or to recall the Open command.

After choosing the Open command you can select the file on which you want to work from a list of files.

You can ...

- open one of the files from the list directly by double-clicking the file name,
- select a different directory by double-clicking the directory name,
- select a different file format for the file display, or
- select a different drive.

To use your keyboard, press the TAB or the SHIFT+TAB keys to move from one field to another; select items from the lists by pressing -, ¯, SPACE and the ENTER key.

In the File Name box you can define the filter for the file list. The default setting for the filter (*.DSQ) will create a list of ***ServiceLab*** Control Sequencer files, which usually have the extension *.DSQ.

Type a different extension, or use wildcards (like ***.***), to display lists of different groups of files. For example, if you have saved ***ServiceLab*** Control Sequencer files with extensions other than *.DSQ (using the Save As... command from the File menu).

However, ***ServiceLab*** can only open files in the special own DSQ format no matter what extension the files have.

2.1.3 Save...

Choose the Save command, or click the function bar icon, to save a Control Sequence file.

If you have created a new Control Sequence file (New from the File menu) without saving it to a file (**untitled** is displayed in the ***ServiceLab*** window title bar), you can select the file name, the directory and the disk drive where the file is to be stored:

- Type the file name in the File Name box.
- If you do not type an extension, ***ServiceLab*** will automatically add the standard extension (*.DSQ). **Name1 always saves worksheet files in its own format, even if you select an extension other than *.DSQ.
- You can...
- select one of the file names in the list by double-clicking the file name. The file that was originally saved under that name will then be replaced with the new worksheet. A warning message will first appear, asking you to either confirm the procedure or to cancel it.
- select a different directory by double-clicking the directory name, or
- select a different drive for the new file.

(To use your keyboard, press the TAB or the SHIFT+TAB keys to move from one field to another; select items from the lists by pressing -, ¯, SPACE and the ENTER key.)

If you have previously saved the Control Sequence to a file (using the Save As... or Save commands from the File menu), or if you have opened an existing file (command Open... from the File menu), its name is displayed in the ***ServiceLab*** window title bar.

Select the Save command, or click the function bar icon, to save the current Control Sequence file. The existing file will be replaced without further messages.

2.1.4 Save As…

Choose the Save As command to save a Control Sequence with a new file name, in a different directory, or on a different drive.

After you have chosen the Save As**...** command from the File menu you can select the file name, the directory and the disk drive where the file is to be stored.

- Type the file name in the File Name box.
- If you do not type an extension, ***ServiceLab*** will automatically add the standard extension (*.DSQ). ***ServiceLab*** always saves Control Sequence files in its own binary format, even if you select an extension other than *.DSQ.)
- You can...
- select one of the file names in the list by double-clicking the file name. The file that was originally saved under that name will then be replaced

with the new Control Sequence. A warning message will first appear, asking you to either confirm the procedure or to cancel it.

- select a different directory by double-clicking the directory name, or
- select a different drive for the new file.
- (To use your keyboard, press the `TAB` or the `SHIFT+TAB` keys to move from one field to another; select items from the lists by pressing -, ¯, `SPACE` and the `ENTER` key.)

2.2. Edit Menu

This view does not include an Edit Menu.

2.3. Experiment Menu

See Worksheet Window Menu: Experiment Menu (page 4-22).

2.4. View Menu

See Worksheet: View Menu (page 4-37).

2.5. Options Menu

See Worksheet: Options Menu (page 4-80).

3. Tree View Menus

3.1. File Menu

See Worksheet Window Menu: File Menu (page 4-1).

3.2. Edit Menu

This view does not include an Edit Menu.

3.3. Experiment Menu

See Worksheet Window Menu: Experiment Menu (page 4-22).

3.4. View Menu

See Worksheet: View Menu (page 4-37).

3.5. Options Menu

See Worksheet: Options Menu (page 4-80).

3.5.1 Tree Display Setup

Use the menu command to change the properties of the Display Window.

Display:

- Normal: In the 32-bit version, this setting shows the measurement setup as a structured tree similar to the Windows Explorer. Click onto the elements of the tree to open the next branch or an accompanying dialog box.

  In the 16-bit version, the window is empty.
- Bitmap: Choose this option to insert any picture in BMP or WMF format into the Window. Use the Bitmap... button to select the bitmap file.

The bitmap is not stored with the worksheet, but only a link to that file is stored. The specified bitmap file has to exist in the named directory to be displayed.

- Sorting (not available in 16 bit version): Select the order the modules are displayed in the tree:

  Alphabetically: All modules are listed in alphabetic order.

  Alphabetically, Black Boxes separately: All modules are listed alphabetically, but the modules inserted into Black Boxes are listed separately.

  Class of modules: Modules are assigned to the several module groups and then are listed in alphabetic order.

  Creating order: Modules are listed in the order they were inserted into the worksheet.
- Bitmap Display: The Original Size of Bitmap option shows the inserted bitmap scaled 1 / 1 (Pixels) centered in window. The background of the window is colored as selected in the Option Menu of the Worksheet Window.

  The Stretch Bitmap switch adapts the Bitmap to the window frame. Proportions of picture may be distorted.

  The Tiled setting fills the complete frame with pictures of the bitmap (sized 1/1).
- Background: Click on this button to choose a color for the background.

3.6. Window Menu

The options of this menu are described in Worksheet: Window Menu (page 4-66).

4. Layout Window Menus

4.1. File Menu

See Worksheet Window Menu: File Menu (page 4-1).

4.2. Edit Menu

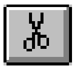
The commands of the Edit menu allow you to copy, paste and delete the ***ServiceLab*** Layout Elements displayed on the screen.

Layout to Clipboard

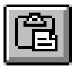
Layout...

Select

Undo


Cut


Copy


Paste

Delete

4.2.1 Layout to Clipboard

Use this command to ***copy*** *the Layout Window as a Windows Metafile (WMF/CLP) to the Clipboard.*

See Worksheet Window Menu: Worksheet to Clipboard (page 4-12).

4.2.2 Layout…

Use this command to save or load Layout Windows onto the worksheet. See Worksheet Window Menu: Layout (page 4-12).

4.2.3 Select Layout Window

Use the menu function to activate the toolbox selection tool.

4.2.4 Undo

*Use this command to undo the **last operation**. All changes to Layout Objects (like modifying colors, size or other properties) are canceled. Choose this function using the Undo menu command or by using the `ALT+Backspace` or `CTRL-Z` key combinations.*

4.2.5 Object Cut, Copy, Paste and Delete

You can copy and paste objects of the Layout Window including their properties:

- **Selection**: First select the objects: click and hold the **left** mouse button inside the worksheet and select the area by dragging the cursor. When you release the mouse button, the selected modules are highlighted. You can select or deselect single objects by clicking the **left** mouse button on the module while pressing the `SHIFT` or `CTRL` key.
- Copy: Choose the Edit/Copy menu command or the `CTRL-INSERT or CTRL-V` key combinations. The selected objects are inserted onto the worksheet with their properties settings intact.
- Cut: To move modules around the worksheet, choose the Edit/Cut menu command or the `SHIFT+DEL` or `CTRL-X` key combinations to remove the objects from the worksheet and to save them for a Paste operation.
- Paste: Now paste the stored objects by choosing the Edit/Paste menu command or pressing `SHIFT+INSERT or CTRL-V`. After activating the insert mode, the mouse cursor changes. Choose the position where the selection should appear. The window is scrolled automatically when the mouse cursor moves outside the window border. Once the mouse cursor is at the destination, press the **left** mouse button to paste the objects into the Layout Window. The paste operation can be repeated.
- Delete: Choose the Delete menu command or the Delete key to delete the selected objects

4.3. Object Menu

Choose the objects you want to insert into the Layout Window. You can also choose objects using the Layout Window Toolbox. The Properties command allows you to change the characteristics of the selected object.

Drawing Elements

Visualization

Text Elements

Properties

Placement

4.3.1 Drawing Elements

Choose this command to select Drawing Elements to be inserted into the Layout:

- Line
- Bitmapped Graphics
- Ellipse – filled or not filled (outline)
- Rectangle – filled or not filled (outline)

You can also choose an element by using the Tool Box buttons.

Click the **left** mouse button inside the Layout Window to define the start position of the Element. Click and hold the mouse button to draw a frame that defines the size of the element. Release the **left** mouse button to complete the command. To set properties of an element, select it with a **left** mouse click. Display the Properties Dialog Box by double clicking on the frame.

Properties (all objects)

Placement: Units for Position and Size are set in Centimeters or Inches depending on the settings in Main Menu File: Page Format.

Color: Use the Color button to select the color in the Windows Color Menu Box. The object will be drawn in the selected color.

Bitmapped Graphics Properties

Drawing **Mode:**

This Option changes how the imported bitmap is shown in the frame.

- Adjusted**:** The Bitmap is resized to the borders. Because the aspect ratio is not maintained, the picture can be contorted.

- Scaled**:** The picture is completely shown in the frame. It is displayed enlarged or reduced with original aspect ratio
- Original: The Bitmap is displayed in its original pixel size (number of pixel in the bitmap = number of pixels on the screen). If the frame is smaller than the bitmap, all parts of the picture rising above the lower and right border are cropped (not displayed).

File Name: This entry shows the name of the Bitmapped Graphics File that will be displayed. You cannot edit this entry. To change the File you must use the File... Button.

The left window of the dialog box shows all available files in directory, the right window shows the directory file structure. The File Format command selects the Bitmapped Graphics File Format (*.BMP, *.WMF). The Drive command selects the drive you want to read from.

⇨ *External Bitmapped Graphics are not stored in the worksheet. Only the name and path of the files will be stored. To display the specified bitmap, the file must be available in the specified directory. Bitmapped Graphics inserted by using the clipboard are stored with the worksheet.*

4.3.2 Visualization

Choose this command to select a Visualization Element to be inserted into the Layout. These elements are linked with the Display Modules of the worksheet. You can create a maximum of 512 linked elements in the VITool Layout Windows.

- Text

  This Visualization Element shows the contents of the alphanumerical displays such as List module or Digital Meter module as dynamic text elements on the Layout page. Only the alphanumeric characters are displayed but not window elements such as borders or window caption.
- Graph

  This Visualization Element shows the contents of the display modules on the Layout page. Only the contents of the display area are displayed but not window elements such as borders or window caption.

You can also choose an element by using the Tool Box buttons.

Click the **left** mouse button inside the Layout Window to define the start position of the Element. Click and hold the mouse button to draw a frame that defines the size of the element. Release the **left** mouse button to complete the command. To set properties of an element, select it with a **left** mouse click. Display the Properties Dialog Box by double clicking on the frame.

Properties (all objects)

Placement: Units for Position and Size are set in Centimeters or Inches depending on the settings in Main Menu File: Page Format.

Linked Text Properties

Link: Choose the name of the module that will send the strings.

Text: Insert the text that should be shown in front of (pre) and after (post) the linked string.

Options

Alignment: Text can be aligned right, left or centered.

90° Rotation: The text Frame will be rotated 90° counter clockwise.

Font: Use the Font button to select font and size in the Text Menu Box.

⇨ *Use only TrueType fonts with rotated Linked Text Objects to prevent problems.*

Linked Graph Properties

Link: Choose the name of the module that will send the graphical information.

Auto Update: If this option is turned off, the display of linked graphical objects is not updated when new data is received. To update manually, use Key Events or Event Driven Actions.

Sync Event Handling: Use this function with synchronous Event Driven Actions to synchronize the Layout display with an event driven action. While this function is disabled, there may be incorrect or inconsistent data when printing a Layout Window (premature or late blocks).

Fast Draw Function: While this Option is active, only the dynamic Elements of the Graphical Object are updated. You will get a better screen view, with less “flashing” as the data is updated.

Display:

- Background: While this option is active, the background in the object frame will not be transparent but will be opaque and colored. To select the color, use the Color... button.
- With frame: While this option is chosen, the object frame will not be transparent but will be visible and colored. To select the frame color, use the button Color....
- Frame as shadow: While this option is chosen, a shadow is displayed on the object frame.
- Width: This entry defines the thickness of the drawn object frame.

Zoom**:** X/Y, Y/t or Recorder Chart modules can be zoomed as well as in the display windows on worksheet:

- Zoom-In: With the Ctrl-key pressed, you can draw a rectangle with left mouse button pressed. The marked area will be scaled to the size of the display area in the graph link.
- Zoom-Out:You can resize the zoomed display with Ctrl-key pressed and a right mouse click in the display area.

Cursors**:** If there are cursors shown in the display window in worksheet or display views, they are also shown in the linked object in the VI-tool Layout Window. You can move the cursors using the mouse. If you want to display the cursor data on your layout page, you must activate the Survey→ Print Cursor Data in VI-Tool menu command in the display window menu. You can access this menu in from the Layout Windows object by right-clicking the mouse. A tear-off menu will appear where you can select command.

Setup: This button opens the Display window Setup dialog of the module linked to that graphic object.

4.3.3 Text Elements

Choose this command to select between two types of Text Elements that can be inserted into the Layout.

- Text Line
- Text Block
- Text Grid

Also you can choose the Elements by using the Tool Box buttons.

Click the **left** mouse button inside the Layout Window to define the start position of the Element. Click and hold the mouse button to draw a frame that defines the size of the Element. Release the **left** mouse button to complete the command. To set properties of an Element; select it with a **left** mouse click. Display the Properties Dialog Box by double clicking on the frame.

Text Line / Block Properties

Placement: Units for Position and Size are set in Centimeters or Inches depending on the settings in Main Menu File: Page Format.

Text: Insert the text that will be shown on Layout.

⇨ *A Text Line is always shown in one line. It will be cut (truncated) at the end of the line. The text of a Text Block will be broken at the end of the line and continued in the next line.*

⇨ *A Text block is always shown in* ***one complete block.*** *It will be broken at the end of line and continued on the next line.*

☝ *You can use placeholders to insert special system information including the date, time, file name, or global variables and strings.*

Grid Text Properties

Select the following Properties:

- Placement: Units for Position and Size are set in Millimeter or Inches depending on the Main Menu File: Page Format settings. Depending on the number of columns, the List is split into columns of the same width. The height of rows depends on the selected font size.
- Setup: The list is shown with the defined number rows and columns.
- Text Setup: The input of row and column number selects the cell to be edited. The text has to be inserted into the edit field below. You can use placeholders to insert special system information (e.g. data, time...).

⇨ *Text in the cells **will not be wrapped** at the cell border but written above the text of the next cell.*

- Alignment: You can set the alignment to left, right or centered.
- Font: Use the Font button to select the font and color in the Text Menu Box. The font size takes effect to the height of the rows of the list on the layout.
- Display

  Background: when this option is active, the background in the object frame will not be transparent but will be opaque and colored. To select the color, use the Color**...** button.

  With frame: when this option is chosen, the object frame will not be transparent but will be visible and colored. To select the frame color, use the button Color**...**.

  Frame as shadow: when this option is chosen, a shadow is displayed on the object frame.

  Width: This entry defines the thickness of the drawn object frame.

Options

Alignment: Text can be aligned right, left or centered.

90° Rotation: The Text Frame will be rotated 90° counter clockwise.

Font: Use the Font button to select the font and size in the Text Menu Box.

⇨ *Use only TrueType fonts with rotated Linked Text Objects to prevent problems.*

Placeholders in Text Objects

You can use placeholders to insert special system information including the date, time, file name, or Global Strings and Strings. The following placeholders are available:

Placeholder	Information Inserted	Available in
`${DEPARTMENT}`	Department from File Info	Text line
`${AUTHOR}`	Name of Author from File Info	Text line
`${DATE}`	Actual System Date	Text line
`${COMPANY}`	Name of Company from File Info	Text line
`${TIME}`	Actual System Time	Text line
`${KEY_ACTIONS}`	List of defined Key Actions	Block text
`${STRING_[No]}`	String No X, defined in Options Menu	Text line
`${STR_[No]}`	String No X, defined in Options Menu	Text line
`${VAR_[No]}`	Variable No X, defined in Options Menu	Text line

⇨ *Insert Strings and Variables Number without the square bracket inside the curly brackets, for example, ${STRING_33} will insert the Global String number 33.*

Right-click on the text entry box to see a pop-up menu that allows you to choose from available Global Strings or Variables, including system variables.

4.3.4 Properties

This command opens the Properties Dialog Box for the Layout page or for the selected Layout object.

4.3.5 Placement

Choose this command to change the position of layered elements. You can move the selected element one layer Up or Down or move them into the Front or Background.

4.4. Experiment Menu

See Main Menu: Worksheet Window Menu: Experiment (page 4-22).

4.5. View Menu

The commands of this menu allow you to change the appearance of the ***ServiceLab*** layout on the screen. Some of these functions can be chosen by clicking the corresponding icons on the Function Bar.

Function Bar

Module Bar

Status Bar

The above options of the menu are described in the Worksheet: View Menu (page 4-37).

Zoom / View

Full Screen

Zoom / View Layout Window

Use this command to zoom the Layout Window (25% to 200%). Use command Fit to Screen and Fit to Page to adapt the Layout Window format of the screen or the page.

Full Screen

Use this command to show the Layout Window in Full Screen Mode. Its size will be adapted to show the whole Layout Window. All elements such as Function Bar, Menu Bar and so on are hidden. Use the ESC key to change to normal mode.

⇨ *To get best results for Full Screen Display use the screen Page Format. You can select it using the properties command of the Object Menu.*

4.6. Options Menu

The commands of this menu allow you to change the display of the ***ServiceLab*** Layout window.

Global Layout Properties

Layout Page Properties

Default Directories

Default Fonts

Colors

Autorouter

Password Protection

Password Definition

Screen Locking

Key Events

Define Global Strings

Define Global Variables

The above options of the menu are described in Worksheet Window Menu: Options Menu (page 4-43).

Layout Window...

Layout Page...

4.6.1 Global Layout Properties

This option allows you to define the starting options of all defined Layout Windows. These options apply to all layouts of the open worksheet. The following settings are available:

- Mouse: While Mouse To Interact With Instruments is active, you can only operate elements like switches or push buttons. You are not able to create objects or modify them.

  To create or modify elements in the Layout Window, you have to switch to the Mouse to interact with Layout Window option.
- View: Choose the Load As Full Screen option to load the first Layout Window into the foreground when ***ServiceLab*** is next started. If the worksheet window was active when ***ServiceLab*** was closed, it will be placed in the foreground.

4.6.2 Layout Page Setup

Use this menu command, or double click anywhere on the Layout Window to open the Properties dialog box. You can change the following:

- Format: Select between DIN or US page formats (Landscape or Portrait) or choose Screen format.
- Name: In the edit field below the format you can define an individual name for this layout window. Instead of the default name, Layout X, the title of the Layout window will be Name X. The layout number is still used by in Action modules to control switching between several layouts.
- Border: You can define Borders. All text objects outside the defined border will be cut off. The Visible option allows you to fade out/in lines that mark the defined borders. The Use border switch activates the clip function.
- Grid: The Snap to grid option places all objects according to the defined grid.

The default Distance of the grid is 5 mm (0.2 inch). To display the grid on the screen, activate the visible option.

The following settings control the display properties of layout objects.

Object Display:

- Show objects only: Only the origin object is displayed on the layout.
- Objects with frames: Objects with their position borders are shown.
- Only frames: Only the position borders are shown.

Objects outside the page

- Hide objects: This selection hides all objects that are placed out of the defined working area.
- Show objects: This option shows all objects, regardless of where they are placed.
- Delete objects automatically: All objects placed out of the working area are deleted automatically.

Moving Objects via keyboard:

This setting defines the steps objects are moved using they arrow keys of keyboard:

- Pixel Size: The selected objects are moved pixel by pixel. Absolute movement of object depends on the chosen zoom factor and resolution of screen.
- Steps of XXX mm: All objects move in steps of millimeters. Relative width of step on the screen depends on the chosen zoom factor and defined size of page.
- Grid Distance: The objects move in steps of the chosen width of grid. Relative width of step on the screen depends on the chosen zoom factor and defined width of grid.

Color Buttons

- Use the background... or Grid... color button to change the colors of the background of the layout sheet or the grid.
- The Default button loads the default settings of that dialog box.

4.7. Window Menu

The options of this menu are described in Worksheet: Window Menu (page 4-66).

5. Help Menu

The commands of the Help menu allow you to obtain on-line help for the following program functions and for your data acquisition hardware. It also provides overviews and on-line tutorials.

5.1. Index

This option activates the Help system and displays the index of topics for which help can be obtained.

5.1.1 Instruction

Click this button to display on-line instruction on how to use the ServiceLab Help System.

Printed instructions on how to use the Help system are found in Chapter 2 of this manual.

Further information on how to use the Windows Help system can be obtained by pressing the F1 function key while using a Help window, or by choosing Using Help from the Help menu.

5.1.2 References

Alphabetic Index of Help Topics / Alphabetic List of Modules

Choose this menu function to view the alphabetical lists containing all the topics for which help is available. Use the scroll bars or press the ↑, ↓, PgUp or PgDn keys to scroll through the lists then click on the topic for which you want information. You can also select a topic by pressing the TAB key until the topic is highlighted, then press ENTER.

Click the Search button at the top of the Help window or press the S key on your keyboard for information on a specific topic.

Glossary

Choose this menu function to view the alphabetical list of terms with definitions that can be displayed as pop-ups on the screen.

*A line indicates the end of each of these definitions. If a line does not appear at the bottom of the text box, your Help window is too small. Enlarge its size by dragging its borders or corners while pressing the **left** mouse button, and click the term again. Or, you can use the Scroll Bar to move around the window.*

Main Menu Options

Choose this menu function to view the Help pages for all of the ***ServiceLab*** menu options and commands.

Module Selection Menu

Choose this menu function to view the Help pages for all of the module groups and modules.

5.1.3 Step by Step Instructions

The Elements of the *ServiceLab* Screen

Choose this menu function to view the overview of the ***ServiceLab*** screen elements found in Chapter 3.

Module Configuration and Manipulation

Choose this menu function to view general comments on how to install, configure, connect, move and delete modules. This information can be found in Module Reference Guide.

Creating your First Worksheet

Choose this menu function to view the instructions found in Chapter 2 of this manual.

5.1.4 Surveys

How to Start/Stop an Experiment

Choose this menu function to view the overview of the menu commands and instructions for automatic experiment control methods that can also be found in Chapter 6 of this manual.

Customizing the *ServiceLab* Screen

Choose this menu function to view the information found in Chapter 3 of this manual.

Worksheet Examples

Choose this menu function to view instructions for using the sample worksheets that are installed with ***ServiceLab***.

ServiceLab by Keyboard

Choose this menu function to view the instructions found in Chapter 6 of this manual.

5.2. Hardware

If you have installed a data acquisition board in your system, choose this menu function to obtain specific help about that board.

Read the Hardware Installation Manual *for additional information concerning installation and operation of your data acquisition device.*

5.3. Glossary

Choose this menu function to view the alphabetical list of terms with definitions that can be displayed as pop-ups on the screen.

5.4. Using Help

This option provides help for how to use the online help system.

5.5. System Information...

Choose this menu function to view information on your hardware, operating system, Windows version, system resources, etc.

5.6. About *ServiceLab*...

Choose this menu function to view information on the current ***ServiceLab*** version.

Your own company logo can be displayed in the INFORMATION *box (see Chapter 6 for details).*

6. Customizing the Main Menu: External Programs

You can easily insert menu items into ***ServiceLab's*** main menu to start external programs directly from within ***ServiceLab***.

Use a text editor, such as Notepad, to make the following entries in the ***SERVICELAB***.INI file (located in the ***ServiceLab*** directory):

```
[External Tools]
ToolNumber=number

ToolMenuText1=&name1
ToolMenuText2=&name2
……Etc.

ToolPathName1=path\programname1
ToolInitialDir1=startingdirectory1
ToolArguments1=startingparameters1
ToolAskArguments1=0

ToolPathName2=path\programname2
ToolInitialDir2=startingdirectory2
ToolArguments2=startingparameters2
ToolAskArguments2=0
……Etc.
```

Each external program has a separate entry as described above. Items shown in *italic* text must be replaced with the actual name, path, and any parameters necessary to start your program. Up to 16 external programs can be defined.

Chapter 5
Files and File Formats / DDE / Network

Chapter 5: Files and File Formats / DDE / Network

1. Files and File Formats

1.1. Worksheet Files (*.DSB)

A worksheet file (standard extension .DSB) contains the complete worksheet with its most important settings.

The following worksheet settings will be saved:

- The type and screen position of all the modules,
- The number of inputs and outputs of each module,
- The settings specified in each module configuration dialog box,
- All the data channels, branches and their exact positions,
- Global settings including the acquisition rate and the block size (Experiment menu),
- All the entries in the File Info dialog box (File menu).

The following environment settings will be saved with the worksheet:

- The mode (normal, minimized...), position and size of the main window and the visualization window,
- The Module Bar configuration,
- All the entries in the Page Format dialog box (File menu).

The following settings will **not** be saved with the worksheet:

- The settings of the Start/Stop at Time functions (Experiment menu),
- The settings of the Auto Start function (Experiment menu),
- The View menu settings for the display of the Module Bar, the Function Bar, and the Animation function,
- The Options menu settings (Window Setup, Colors, and the Autorouter function).

A worksheet file can be viewed in part by using the MS-DOS command TYPE. Some global information like the current time and date, comments, etc., is contained in human readable format at the beginning of the file.

1.1.1 Worksheet Exchange Files (*.DSA)

The file with the extension *.DSA stores a worksheet with the same information as the original ***ServiceLab*** worksheet file (*.DSB), but formatted in ASCII. This format is uses to exchange worksheets between different program versions (16 bit and 32 bit). Saving ASCII format will take a longer time and needs more disk space than storing in DSB format

⇨ *In addition to the *.DSA file **ServiceLab** creates a file with the extension **DMX**, which contains the graphical matrix of the worksheet, such as data channels position of modules and so on. To load a worksheet as ASCII file both files *.DSA and *.DMX has to be available.*

1.1.2 Worksheet Text Files (`*.TXT`)

This file format with the extension *.TXT contains simple text, which describes the modules and settings used in the worksheet. This file is only useful to rebuild worksheets manually. ***ServiceLab*** is **not able to reload** these files, because all graphical information, such as position of modules or data channel links, is not stored.

1.1.3 HTML Text Files (`*.HTM`)

This file format is used to save worksheets as HTML files, using **H**yper**T**ext **M**arkup **L**anguage, as used in the Web. These files contain all elements and important settings of a worksheet. The files cannot be reloaded but are a powerful help for documentation and rebuilding your projects

1.2. Control Sequencer Files (`*.DSQ`)

To control large application controlled by more than one worksheet calling each other use the Control Sequencer Window. The contents of this window is stored in a binary file, the Control Sequencer file with the suffix *.DSQ.

You can add any number of worksheets into the Control Sequencer File and also you can define several actions for each inserted worksheet to rule the course of the worksheets.
The contents of the Control Sequencer File is shown and edited as new display window (in analogy to the worksheet, display and VITool windows).

⇨ *The file format type is binary, so you cannot edit it in a standard ASCII Editor.*

1.3. Module Bar Files (`.DML`)

These files contain configurations of the Module Bar and are used to define ***ServiceLab*** environments for different application areas. They can be created by choosing the Save As... command from the Module Bar submenu of the Edit menu.

The current configuration of the Module Bar will be saved by ***ServiceLab*** in the file ***SERVICELAB***.DML. This file will by default be used for the next start of ***ServiceLab***.

1.4. Layout File (`.LAY`)

These files contain configurations of the Layouts and are used to save user defined Layout settings to import into different worksheets. They can be created by choosing the Save As... command from the Edit submenu: Layout...

1.5. Serial Port Settings (`.SIN/.SOU`)

The settings of the serial interface are stored in these files. They can be created by choosing the Save Button in the module dialog box of the serial modules. Load these files to quickly configure the ports with previously defined settings.

1.6. Initialization File (`SERVICELAB.INI`)

ServiceLab automatically creates this file in the Windows directory. It contains the current global settings concerning the main windows and parts of the file info. Also in these files defined Global Strings or variables are saved. If necessary ***ServiceLab*** can read them while measurement is running.

1.7. Files with Reference Points (`.DPF`)

These ASCII files contain lists of reference points that are required for Interpolation in the Scaling module. Use an ASCII editor such as Windows Notepad or any other non-formatting text editor to create such a file.

The file can be created as one channel file or multi channel file and must be structured as follows:

Line 1: `INTERPOLATION`
Line 2: identifier (maximum 40 characters)
Line 3: number of columns (minimum 2)
Line 4: number of pairs of data
The lines containing the data pairs follow. Their total number must correspond exactly to the value specified in line 4.
Last line: `EOF`

The reference pairs are arranged in one line with the independent value first and the dependent value second. Blanks or Tabs must separate the two columns. The lines must be sorted in increasing order.

Example of an Interpolation file:

```
INTERPOLATION
This is an example file.
2
5
-2000    0
-1500    1.5151
-100     3.7456
10       7.78569
400      0.12
EOF
```

Example of a Multi Channel Interpolation file with 3 channels separated by blanks:

```
INTERPOLATION
This is a 3-channel example file.
3
5
-2000   0.00     1.00
-1500   1.5151   2.50
-100    3.7456   3.5678
10      7.87569  2.222
400     12.587   3.334
EOF
```

1.8. Data Files

ServiceLab can store data in different formats so that data can be used by other applications. It can read data stored as IEEE-32 or ASCII formats, in addition to its own format. Use the Read File and Write File modules from the Files module to read and write files.

ASCII Format (`.ASC`)

Data is stored as ASCII strings, so that it can be read without an additional converting program.

⇨ *Only continuous time-dependent data can be stored in the* ASCII *format.*

IEEE Format (`.I32`)

Data is stored as IEEE 32 bit floating point values in the Intel format.

⇨ *Only continuous time-dependent data can be stored in this format.*

External Formats

ServiceLab supports saving data in any of the following formats:

Format	Extension	Format	Extension
ASCII	*.ASC	IEEE-32	*.I32
DADiSP	*.DSP	Remus	*.DAT
DIA/DAGO	*.DAT	Signalys	*.VH, *.K??, *.D??
Famos	*.DAT		

⇨ *FFT, Histogram, or Relay data cannot be stored in the DIA/DAGO format. The same block size and sampling rate must be specified for all the channels if data is to be stored in this format.*

There are no restrictions for the Famos or the Signalys formats.

DASYTEC Data Format (`.DDF/.DDB`)

This format is the DASYTEC format that exactly fits the requirements of ***ServiceLab***.

Data can be stored and read in this format. All types of data can be saved and the full information is stored together with the raw data.

Please refer to the section 1.9 for further details.

1.9. DASYTEC Data Format (`.DDF/.DDB`)

(Extended Version 1.01 / Oct. 1994)

1.9.1 Basics

The header can either be stored in the same file as the data or in another file with a different extension.

The extension for the main file is .DDF (“DASYTEC **D**ata **F**ormat”). If a separate data file is created, its extension will be .DDB (“DASYTEC **D**ata **B**lock”).

The format itself is not fixed completely, but contains options for future development. Any variants of the format that are not described explicitly here are not fully developed and should not be used.

1.9.2 Basic File Structure

Each file consists of four sections, of which the one containing the data may be stored in a separate file:

1. Two global headers,
2. A number of channel headers (one for each channel),
3. One or several series of data blocks,
4. The End of File mark;

Or

1. Two global headers,

2. A number of channel headers (one for each channel),
3. The End of File mark,

Plus an additional file containing only the series of blocks of data.

The current version allows only one series of blocks of data.

1.9.3 Storing Different Types of Data

Binary data are stored following the conventions of the Intel Format. This documentation uses the following identifiers for data types:

- CHAR single character
- CHAR[n] an array of exactly n characters
- INT 2 Byte signed
- LONG 4 Byte signed
- WORD 2 Byte unsigned
- DWORD 4 Byte unsigned
- DATUM date and time in the current MS-DOS format
- FLOAT 4 Byte real
- DOUBLE 8 Byte real
- STRING a series of characters with NULL Byte terminator (variable size)

Strings will be encoded according to Windows 3.1 conventions.

1.9.4 The First Global Header

The first global header has the following structure:

`CHAR[4]`	fixed file identifier: 'D', 'T', 'D', 'F'
`CHAR`	fixed file identifier: CTRL-M ($0D)
`STRING`	data source, comments, etc. (see below)
`CHAR`	fixed terminator: CTRL-Z ($1A)
`CHAR[2]`	fixed CPU identifier: 'I', 'N'
`WORD`	size of this header in Bytes
`WORD`	file type (see explanation below)
`WORD`	version number (currently: 1)
`WORD`	size of the second global header in Bytes [*] (see explanation below)
`WORD`	size of a channel header in Bytes [*]
`WORD`	size of a block header in Bytes
`WORD`	flag for a separate data file
`WORD`	number of channels
`DOUBLE`	time delay between two samples
`DATUM`	start time

- The “Data Source” string is structured by ***ServiceLab*** as follows:

```
SERVICELAB V 3.00 [APRIL 15, 1993] -- Copyright
            (c) 1992,93,94,95 by NATIONAL
            INSTRUMENTS
WORKSHEET = WIND.DSB
AUTHOR = W. Inner
COMPANY = Faster Than Light Inc.
DIVISION = Development
TITLE = Wind channel experiment 4711
SAMPLE RATE = 1000.0 Hz
DATA FORMAT = 1
DATA CHANNELS = 5
START TIME = MAY 25, 1995 11:55
```

If data blocks are stored in a separate file, the following line is added:

DATA FILE = NAME.DDB

You can view this information using the MS-DOS command TYPE.

- "File Type" may be one of the following values:

0	streamer format (data are raw data in WORD format, coming directly from the DAQ)
1	Universal Format 1 (FLOAT)
2	Universal Format 2 (DOUBLE)
3 – 1000	reserved
1001 – 65535	unused

Currently only File Type 1 is supported.

The second global header is dependent on the file type.

For the above sizes marked with an asterisk [*****] (and only those), strings are counted as 1 Byte each. Otherwise the real size will be entered. The data block headers cannot contain any strings.

The flag for separate data files may have either of these values:

0	(FALSE)	one file only / header and data are in the same file.
1	(TRUE)	separate file for data blocks. Both files must have the same file names, but the extension of the main file is .DDF ("DASYTEC **D**ata **F**ormat"), and the extension of the separate data file is .DDB ("DASYTEC **D**ata **B**lock").

1.9.5 End of File Mark

The end of file is marked by:

CHAR[4]	fixed label: 'D', 'T', 'D', 'F'

1.9.6 The Universal Format 1

This is the standard format of ***ServiceLab***. All the different types of signals can be stored in this format.

Global Header for Universal Format 1

This header has the following structure:

WORD	size of this header
WORD	number of channels
(with multiplexed data total amount of channels)	
WORD	Flag, whether the data are multiplexed (0=no; 1 = yes)
WORD[16}	Array of the channels collected on each input channel

Channel Header for Universal Format 1

Each channel has its own header:

WORD	size of this header
WORD	channel number
WORD	maximum size of a block in samples. The maximum value is 8192. The actual sizes of the blocks may be smaller.
DOUBLE	time delay between two samples in this channel
WORD	channel type (see explanation below)
WORD	channel flags (see explanation below)
DOUBLE	unused, must be 0.0 for future extensions
DOUBLE	unused, must be 0.0 for future extensions
STRING	channel unit
STRING	channel name

- The following channel types may be used:

Value	for a channel containing data of the following type:
Channel Type = 0	continuous time dependent signals
Channel Type = 10	frequency dependent data (full block size)
Channel Type = 11	frequency dependent data (half block size)
Channel Type = 20	Histogram values
Channel Type = 21	Histogram values with time information

- The channel flags may be used for special properties of a signal or block; currently only one flag is defined:

Channel Flag $0001	data in this channel may have gaps
Channel Flag $0002	this channel may contain shorter blocks

The different channel headers follow one by one without gaps. The first header corresponds to channel 0, the second to channel 1 and so on.

1.9.7 Data Block Header for Universal Format 1

Each series of data blocks is preceded by a small header structured as follows:

CHAR[4]	fixed label: 'D', 'A', 'T', 'A'
WORD	overall number of bytes in this channel
DATUM	start time for the following blocks
DWORD	unused, must be 0.0 for future extensions
DWORD	unused, must be 0.0 for future extensions

This header is followed by the corresponding series of data blocks, each of which is again introduced by its own separate header.

The individual pairs of headers and blocks directly follow each other. The blocks are not sorted according to channels but according to their start time.

- Channels of types **0**, **1**, **10**, **11** or **12** have headers as follows:

WORD	channel number
DOUBLE	start time
DOUBLE	time delay between samples
WORD	block size

This header is immediately followed by the data in 4-byte float format.

- Channels of type **20** (Histogram data) have the following header:

WORD	channel number
DOUBLE	position of the first histogram value
DOUBLE	width of the classes
WORD	number of samples

This header is immediately followed by the data in 4-byte float format.

These data are not provided with time information.

1.9.8 The Universal Format 0

Universal Format 0 is used for streaming data. It may contain more than 16 channels and it may contain data in raw integer format.

Global Header for Universal Format 0

This header has the following structure:

WORD	overall number of bytes in this header
WORD	number of analog channels
WORD	number of counter channels
WORD	number of digital ports
WORD	number of bits in each digital port
WORD	original block size when data was stored
DWORD	sample number of the first sample (when cyclic buffer is not activated, always zero)
DWORD	number of samples per channel

Channel Header for Universal Format 0

WORD	number of bytes in this header
WORD	channel type 0: analog, 1: digital, 2: counter

CHAR	array 16 by 24 with channel names (channel names with 24 chars for digital ports)
WORD	data format 0 unsigned integer, 1: signed integer
DOUBLE	factor for calculation of Volts
DOUBLE	offset for calculation of Volts

1.10. Vector File (`*.VEC`)

The vector file (Extension `*.VEC`) stores information used in the module Convolution.

You can create this file with an ASCII editor such as Windows Notepad or any other non-formatting text editor. The file must be structured as follows:

(Quotation marks are inserted for better view. They are not allowed to be used in original vector file!)

1st line:	"`VECTOR`"
2nd line:	Name (free text, max 40 characters)
3rd line:	Number of columns; only „1" is allowed
4th line:	Number of data lines
Next lines:	Data (number of lines exactly as defined in previous line)
Last line:	„`EOF`"

Example of Vector file

`VECTOR`	
`Example of vector file`	name
`1`	number of columns „1"
`5`	number of data lines „5"
`121`	Data line 1
`244`	Data line 2
`305`	Data line 3
`476`	Data line 4
`599`	Data line 5
`EOF`	

1.11. FGEN File (`*.TXT`)

The FGEN file (Extension `*.TXT`) stores Coefficients of Filter, which are used in the Convolution module.

It is possible to use the program FGEN for Windows (Version 1.00, 20 October 1995, Microstar Laboratories) to import immediately coefficients of digital filters into the convolution module. Because the FGEN program isn't able to store the coefficient matrix you must use the menu item „View..." to show the coefficient values and copy them into the clipboard.

You can import this data into an ASCII editor such as Windows Notepad or any other non-formatting text editor and store it as a TXT file.

Example FGEN FILE

```
; vector v: Taps = 95, Type = Lowpass, Window = Blackman
; vector v: Actual Taps = 101 (before zero stripping)
; vector v: Edges = 0,09, 0,14
; vector v: Scale = 8
vector v = (-1, -1, -2, -1, 1, 6, 14, 24,
    35, 43, 44, 34, 8, -36, -97, -170,
    -243, -300, -321, -284, -173, 20, 288, 608,
    937, 1214, 1369, 1332, 1045, 479, -356, -1398,
    -2530, -3589, -4372, -4665, -4268, -3023, -848, 2246,
    6140, 10610, 15343, 19968, 24091, 27345, 29429, 30147,
    29429, 27345, 24091, 19968, 15343, 10610, 6140, 2246,
    -848, -3023, -4268, -4665, -4372, -3589, -2530, -1398,
    -356, 479, 1045, 1332, 1369, 1214, 937, 608,
    288, 20, -173, -284, -321, -300, -243, -170,
    -97, -36, 8, 34, 44, 43, 35, 24,
    14, 6, 1, -1, -2, -1, -1)
```

2. *ServiceLab*-Network: Communication with other programs

ServiceLab -Network is able to control other programs (like OPC servers) running on connected machines. A typical configuration is a central computer that controls all functions (a master) and many measuring points that are controlled (slaves).

There are always two machines involved in any communications connection. Usually they are called Client/Server. Also we will use the terms Master/Slave or Active/Passive Partner.

The computer that actively builds and controls the connection is the Client, Master or Active Partner. It sends commands and performs supervising functions. It also sends or receives data initiated by itself. The Client or Master computer always has the main control.

The Server, Slave or Passive Partner is the computer that waits for another computer to contact it. It accepts commands, receives data and sends data controlled by the far side. Server or Slave computers are not able to operate without the control inputs of the Server. It only executes commands of the Master unit.

The Remote Control Dialog Box allows you to define ***ServiceLab*** -Network as Client or Server. With Server mode there are no further settings. With Client mode you can define a list of Servers that should be controlled. The settings of each of these Servers can be defined using the Option button or the servers can be ordered to execute immediate instructions.

The Options Dialog Box defines the settings of the remote control operations.

- Start/Stop simultaneously

  When this option is active, the Server starts and stops each time the measurement starts and stops. Please note that Clients and Servers never start at exactly the same time because the transmission of the start command is dependent on the utilization and capacity of the network. Also network configuration, speed of network boards, etc., will affect the speed of the transfer.
- The Start, Stop and Load Options are executed immediately. Start measurement, stop measurement or loading a worksheet will be performed on the remote side "instantly."

2.1. TCP/IP Network Protocol

The TCP/IP Protocol is the basis of ***ServiceLab*** -Network functions. It is not included in the standard Windows or Windows for Workgroups installations. You will need to install the TCP/IP Stack to use the ***ServiceLab*** -Network functions.

Availability

Several manufacturers provide TCP/IP Protocol Stacks as a supplement to Windows 3.1 and/or Windows for Workgroups 3.11. ***ServiceLab*** -Network only works correctly with TCP/IP Stacks that include a WINSOCK DLL file. This file should meet the Windows Sockets Specification Version 1.1, Jan 20, 1993.

MS TCP/IP-32

The TCP/IP-32 Protocol Stack is provided free of charge by Microsoft. This stack (in contrast with others) cannot only be used with Windows 3.1 but also with Windows for Workgroups 3.11. It is very easy to install. New operating systems such as Windows 95 will contain the TCP/IP Protocol in the standard distribution.

The following section refers to the MS TCP/IP-32 Protocol stack.

Installation

MS TCP/IP-32 installation is started using the network setup from the Network Group. You can install it as an additional protocol using the driver options.

Typically you would first install the Microsoft Windows Network with an installed Ethernet board. Then install the TCP/IP-32 as an additional protocol.

Installation of additional Network protocols (such as Novell Net or others) is not required because each additional protocol running on the network diminishes the overall performance.

IP-Address

During the installation of TCP/IP, all mounted computers must have an IP Address (= Internet Address). The string is constructed of 4 numbers divided by decimal points (for example: 192.153.120.3) and has to agree with established declarations (for example, the first number defines the Address Type.)

If you want to connect your local network with the worldwide Internet, you must request the first three numbers from the network provider. The last number will define the local computer.

Also, while the network will work, local Internet conventions must be obeyed. For example, usable addresses are 192.153.120.x in which each local computer gets its station identification defined in the x component (range: 1 up to 255). The first three numbers of all local computers must be identical. Each local machine must be named unambiguously. This name is also used by ***ServiceLab***.

2.2. Bibliography

Reviewing the literature, there are many books, articles, etc., which discuss TCP/IP, Internet and Windows Sockets.

References with subjects of Ethernet, FDDI, Using IP-Addresses, etc., are interesting if you want to install a TCP/IP Network.

Subjects of FTP, TELNET, NFS, EMAIL, WWW (Worldwide Web), GOPHER, and so on are descriptions of public domain services that are not necessary to run ***ServiceLab***.

You won't need descriptions of Windows Sockets. You only need to know that ***ServiceLab*** needs Windows Sockets. The software manufacturer has to deliver them with the TCP/IP Stacks.

3. DDE: Communication with Other Applications

DDE (**D**ynamic **D**ata **E**xchange) is defined as a dynamic data exchange between Windows applications using a defined protocol. Although this conversation is two-way, the role of each program is determined by the protocol. The program asking for data is called the Client. The called program is defined as the Server.

The Client always initiates a DDE conversation. It sends an initialization message (WM_DDE_INITIATE) to all running tasks. The parameters describe the general type of the required data. A program with that data type responds with an acknowledgment and declares itself to be the Server. A DDE conversation is restricted to two partners.

3.1. *ServiceLab* as DDE Input

Using the Windows DDE Interface, external programs are able to initiate ***ServiceLab*** functions (load file, start measurement...) in a running ***ServiceLab*** pro-

gram. Other Windows applications can control ***ServiceLab***. In this case ***ServiceLab*** is the Server, a Visual Basic application, for example, is the Client.

The format of the DDE instructions has to conform to the following rules:

Service:	***ServiceLab***
Topic:	**`Menu`**
Item:	**`Command`** e.g. **`Load`**

The name of the application (service) ***ServiceLab*** and the topic **`Menu`** starts the DDE conversation. Available items are **`Command`** (standard menu command) with start measurement, stop measurement, pause measurement and continue measurement functions and the item **`Load`** to load file.

There are 6 additional DDE items to manipulate Global Strings or Variables using DDE:

- SetString
- GetString
- SetVar
- GetVar
- GetData
- SetData

In both **GET** functions the number is chosen as item and the function as topic (***ServiceLab*** is the DDE server. Connection is a **Cold Link**). ***ServiceLab*** will send back the result as an ASCII value. If there is no result (wrong number, etc.), ***ServiceLab*** will send back the string **'Parameter Error'**. To set strings or variables (***ServiceLab*** is DDE server, connection is defined as DDE Poke) the number and the defined alphanumeric string or numerical value separated by a semicolon will be sent. ***ServiceLab*** gives no feedback.

Protocol

Application: ***ServiceLab***

- **Start measurement, stop measurement, pause measurement, continue measurement:**

Topic:	**`Menu`**
Item:	**`Command`**
String:	**`START, PAUSE, CONT, STOP`**
Communication:	**`Poke`**

- **Load file:**

Topic:	**`Menu`**
Item:	**`Load`**
String:	**`FILEname`**
Communication:	**`Poke`**

- **Set Global String:**

  Topic: **`Menu`**
  Item: **`SetString`**
  String: **`Number;String`**
  Example: **`3;test.ddf`**
  Communication: **`Poke`**

- **Get Global String:**

  Topic: **`Menu`**
  Item: **`GetString`**
  String: **`Number`**
  Communication: **`Cold link`**

- **Set Global Variable:**

  Topic: **`Menu`**
  Item: **`SetVar`**
  String: **`Number;(ASCII)Value`**
  Example: **`2;5.923`**
  Communication: **`Poke`**

- **Get Global Variable:**

  Topic: **`Menu`**
  Item: **`getVAR`**
  String: **`Number`**
  Communication: **`Cold link`**

- **Get DDE data**

  Topic: **`GetData`**
  Item: **`MODULEname`**
  String: **`Line with x channels, (ASCII)`**
  Communication: **ColdLink** or **HotLink**

- **Set DDE data**

  Topic: **`SetData`**
  Item: **`MODULEname`**
  Communication: **`Poke`**

Visual Basic - example

```
Private Sub cmdPoke_Click()
   txtData.LinkMode = vbLinkNone
   txtData.LinkTopic = "ServiceLab" & "|" & "Menu"
   txtData.LinkItem = "Load"
   txtData.LinkMode = vbLinkManual
   txtData.Text = "c:\ServiceLab\last.dsb"
   txtData.LinkPoke
End Sub
```

```
Private Sub cmdRequest_Click()
   txtData.LinkMode = vbLinkNone
   txtData.LinkTopic = "ServiceLab" & "|" & "GetVariable"
   txtData.LinkItem = "1"
   txtData.LinkMode = vbLinkManual
   txtData.Text = ""
   txtData.LinkRequest
End Sub
```

In VisualBasic 5.0 the type of communication is declared as follows:

Poke:	Linkmode: txtdata.LinkMode = vbLinkManual	
	Initialization:	txtdata.Poke
ColdLink:	LinkMode: txtdata.Linkmode = vbLinkManual	
	Initialisation:	txtdata.Request
HotLink:	LinkMode: txtdata.LinkMode = vbAutomatic	

When the connection is successful, an acknowledgment signal (“CONNECT”) will be sent.

Net DDE

It is also possible to exchange data between programs running on different machines using an available **network**.

You need to ensure the following:

- On the server side there must be one or more DDE shares entries. This authorizes other applications (in the following example `Excel`) to connect via Net DDE. Shares are inserted in the SYSTEM.INI file section `[DDEShares]`.

  Example:

  ```
  [DDEShares]
  CHAT$=winchat,chat,,31,,0,,0,0,0
  SCHAT$=winchat,chat,,31,,0,,0,0,0
  CLPBK$=clipsrv,system,,31,,0,,0,0,0
  DL_MENU$=ServiceLab,Menu,,15,,0,,0,0,0
  DL_DATA$=ServiceLab,DdeData,,15,,0,0,0
  XL_TAB1$=Excel,Tab1,,15,,0,0,0
  ```

  ServiceLab requires the last three lines.

  You need to restart Windows to initiate the connection.

- On the client side the following entries are necessary:

  When ***ServiceLab*** and the other application are installed on the same machine:

  Application: `Excel`
  Topic: `Tab1`

Item: `R1C2`

When ***ServiceLab*** and the other application are connected via Net DDE:

Application: `\\ComputerName\NDDE$`
Topic: `XL_1TAB1`
Item: `R1C2`

Adjustments of the client must match the enabled DDE shares settings.

Chapter 6
Tips & Tricks

Chapter 6: Tips & Tricks

1. Demo Worksheets

When you set up ***ServiceLab*** on your hard disk, several Sample Worksheets are copied to the ***ServiceLab*** directory.

You can open these files onto the working area by choosing Open from the File menu or by clicking this Function Bar icon.

These worksheet examples can give you some idea of the wide range of measuring tasks that can be solved by ***ServiceLab***.

If you choose the File Info command from the File menu, or click the corresponding icon on the Function Bar, you will find information on that worksheet in the Worksheet Information box.

2. *ServiceLab* by Keyboard

Most Windows applications are designed with mouse operation in mind, but the keyboard may also be used. The following keyboard operations can be used in ***ServiceLab***:

Menu Commands

Menu commands can be chosen by pressing ALT to move to the Menu Bar, then typing the underlined letter in the menu name to open the menu, and then typing the underlined letter in the menu command.

Experiment Control

Keyboard shortcuts are provided for commonly used Experiment menu commands. Instead of opening the menu and choosing the command, press the key combination.

These keys are listed to the right of the menu entry. The online help pages also list them.

A list of the commands and their shortcut-key combinations is provided on page 6-2.

Module Manipulation and Configuration

The module symbols in the worksheet can be dragged, connected by data channels, configured, or deleted. The latter two manipulations can also be done with the keyboard.

Only one module in the worksheet can be selected and manipulated. It is identified among the module symbols in the work area by the inverse coloring of its Title Bar, where the module name is displayed.

- To select a module, click it once with the **left** mouse button or press the TAB key on your keyboard until that module is selected.
- When you press the ALT+ENTER keys, the module configuration dialog box appears. Press the TAB or the SHIFT+TAB keys to move from one field or button to another; select items by pressing the arrow keys, the SPACE and the ENTER key.

⇨ *Channel Selection can only be done using the mouse.*

- To copy settings entered for the selected channel to the other activated channels, use the F7/F8 Function Keys. This procedure can only be performed using keyboard operation.
- To delete the selected module from the worksheet, or to delete all the input and/or output channels of that module, press the DEL key. In the dialog box, select the desired option, or choose Cancel, and press ENTER.

3. *ServiceLab* Hotkeys

F1	Online Help
F2	Show Display Window
F3	Show Worksheet Window
F4	Show Layout Window
F5	Start Measurement
CTRL+F5	Stop Measurement
CTRL+F6	Pause Measurement
CTRL+F6	Resume Measurement
F7	Copy selected channel properties
F8	Copy all channel properties
ESC or CTRL+F	Switch Layout into window mode
CTRL+F	Switch Layout into full screen mode
ALT+SHIFT+Number	Save window arrangement
Alt+Number	Choose window arrangement
ALT+CTRL+Number	Delete window arrangement

4. How to Start and Stop an Experiment

This section contains

- Some basic information on the options provided by ***ServiceLab*** to control an experiment or data acquisition process;
- An overview of the manual control options;
- And a review of the methods for automatically controlling an experiment.

4.1. Start/Stop/Pause/Resume an Experiment

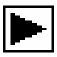
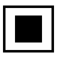
ServiceLab allows you to control your data acquisition procedures in various ways. Besides starting and completely stopping an experiment you can also interrupt it and later resume it at that point.

- When you pause an experiment, the acquisition of new data is stopped (for example, Generator, A/D or Digital Input, PID or Manual Control modules) but data already acquired will be processed completely.
- The acquisition of new data is resumed when the experiment is continued.

4.2. Controlling an Experiment Manually

There are three methods for controlling an experiment manually:

- Choose the commands from the Experiment menu: click the menu item, or press the ALT, X keys, then type the letter that is underlined in the item name.
- Click the icons on the Function Bar. Each icon symbolizes a menu commands.
- Use keyboard shortcuts. When available, shortcut-key combinations are listed to the right of the menu item; to use, press the key combination.

Icon	Experiment Menu Command	Hotkey	Function
	*Start*	F5	*Start experiment*
	*Stop*	CTRL+F5	*Stop experiment*
	√*Pause*	CTRL+F6	*Pause experiment / resume experiment*

4.3. Automatic Program/Experiment Start

The experiment setup (the worksheet) and/or the computer can be configured so that the experiment will start and stop automatically.

The following describes the menu commands needed and the details on how to automatically set up experiments using batch files and Windows resources.

⇨ *The concept of Event Driven Actions enlarges the capabilities of **ServiceLab** in the field of automatic measurement control. An Action module can react to detected events with certain activities, such as opening and starting a new worksheet, printing displays, resetting values, etc. See the Module Reference Guide for more information.*

4.3.1 Start/Stop via DDE

Other Windows applications with DDE capabilities can be used to start and stop the ***ServiceLab*** experiment. Refer to the DDE section in Chapter 6 for details on the DDE protocol.

4.3.2 Start/Stop at Time

Choose the Start/Stop at Time option from the Experiment menu to start, stop, and repeat an experiment at specified times. You can specify the time at which an experiment is to start, the duration of that experiment, and the interval after which the experiment is to be repeated. Refer to Chapter 6 for details.

4.3.3 Using the Auto Start Function

Use the Auto Start option from the Experiment menu to set an experiment to start automatically.

- Activate the Auto Start option from the Experiment menu (indicated by a check mark √).
- Choose Save or Save as... from the File menu, or click the Function Bar icon, to save your worksheet. When you exit ***ServiceLab***, the setting of the Auto Start option is saved with other window settings.
- To use Auto Start, append the file name of the worksheet to the program file name at the command line. ***ServiceLab*** opens the worksheet and starts the experiment immediately.

4.3.4 Starting a Worksheet from the Windows Desktop

Drag and drop your worksheet files onto the Windows desktop. To automatically start ***ServiceLab*** by double clicking on the worksheet, you first have to manually create a link from ***ServiceLab*** to the file type. First, use the Drag & Drop method to place a worksheet file icon on the desktop. Because there is no defined link to any program, double clicking on this icon will open a dialog box. Windows will ask you what program should be used to open that file. Select the: File always

open with ... radio button and select the Others... button. Windows will open an Explorer Window that allows you to select a program. Choose the ***ServiceLab*** installation path and select the ***SERVICELAB***.EXE program. Use the Open button to confirm. Leave the dialog box using the OK button. In the future, ***ServiceLab*** will automatically start when a worksheet icon is double clicked.

If you have installed several copies of ***ServiceLab*** on your system, the created link connects only to one version of ***ServiceLab*** from the Windows Program Manager or File Manager.

4.3.5 Starting Control Sequence Files from the Windows desktop

Using Windows 95/98 or 2000/NT you can place your Control Sequence files with Drag&Drop onto the Windows desktop. To automatically start ***ServiceLab*** by double clicking on the Control Sequence file, you first have to manually create a link from ***ServiceLab*** to the file type. First, use the Drag & Drop method to place a Control Sequence file icon on the desktop. Because there is no defined link to any program, double clicking on this icon will open a dialog box. Windows will ask you what program should be used to open that file. Select the: File always open with... radio button and select the Others... button. Windows will open an Explorer Window, which allows you to select a program. Choose the ***ServiceLab*** installation path and select the ***SERVICELAB.***EXE program. Use the Open button to confirm. Leave the dialog box using the OK button. In the future, ***ServiceLab*** will automatically start when a worksheet icon is double clicked.

If you have installed several copies of ***ServiceLab*** on your system, the created link connects only to one version of ***ServiceLab***.

4.3.6 Tips for starting worksheetscontrol sequences if you have more than one *ServiceLab* versions on the same computer

If there are several ***ServiceLab*** versions (e.g. German and English versions) installed on your system, you can create links to worksheets for each version. Because ***ServiceLab*** doesn’t use the extension to identify the worksheet file, you can rename the worksheets of each version to a special extension (e.g. German worksheets with *.dws). Now you can create a new link in Windows as described before and each worksheet will start with the corresponding ***ServiceLab*** version by a double click. You have to pay attention to previously defined extensions, so that you don‘t affect other installed software.

4.3.7 Various Application Icons or Batch Files

You can customize the start-up modes described above.

Batch Files

Create a batch file containing the command line described above, including the worksheet file name and save it with a descriptive file name. Set up several batch files, each with an experiment setup.

Any experiment can be then started by typing the corresponding batch file name.

Application Icons in Windows Program Manager

Add a new option to the ***ServiceLab*** application icon displayed in the Windows Program Manager, or create a special icon for an experiment in your ***ServiceLab*** program group in the Windows Program Manager.

- To keep the current program startup option without a worksheet, copy the ***ServiceLab*** icon first. Select it, press the `F8` function key, or choose Copy from the Program Manager File menu.
- Select the copied ***ServiceLab*** icon with one mouse click, and press the `ALT+ENTER` keys, or, choose Properties from the File menu.
- Type the complete worksheet file name including its drive, directory, and extension after the ***ServiceLab*** command in the Command Line box.

  For example:

  `C:\SERVICELAB\SERVICELAB.EXE D:\FLCS\FLC1.DSB`

  where `FLCS` is the directory on drive `D:` where your worksheet files are saved, and `FLC1.DSB` is the experiment setup file which is to be automatically started.
- In the Description box, type a description that identifies the worksheet.
- Press `ENTER`.

Any experiment can be started directly by clicking on the corresponding Program Manager icon.

4.3.8 Starting an Experiment at the same time as Windows

Copy one of the experiment icons to the Windows Program Manager `AUTOSTART` group to start the experiment when Windows is started.

4.3.9 Starting an Experiment when your Computer System Restarts

Add the Windows command to the `AUTOEXEC.BAT` file and the experiment will start when you start your computer system.

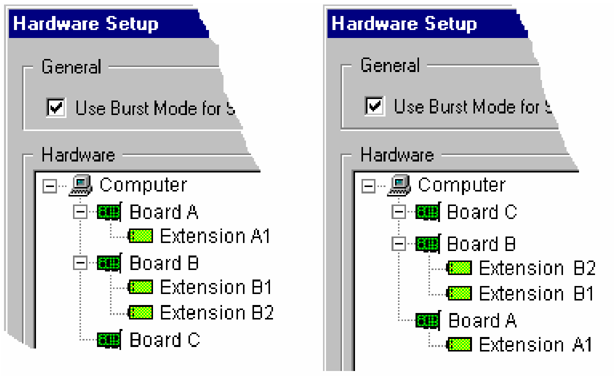
5. Exchanging Worksheets

Between Computers

If you have to exchange worksheets between several PCs (for example, when setting up runtime applications), you must guarantee that the selection and sequence of measurement hardware (Experiment: Hardware Setup) in the source ***ServiceLab*** are exactly the same as in your target PC. If not, there may be problems with hardware specific modules. This is usually only a problem when using **more than one DAQ board** (multifunctional drivers) or **boards with extension boards**. The hardware configuration specified in the hardware setup is stored as a list of indices in the worksheet without a board-specific indication. The result of a different sequence is an incorrect setup of hardware modules.

Similarly, the hardware settings, including the base address and/or channel of the single components have to be identical.

The following picture shows parts of the hardware setup of different PCs with the same set of measurement hardware but with a different setup sequence, which causes incorrect hardware assignment.



Between Versions Of The Software

ServiceLab worksheet files, *.DSB, are forward compatible with newer versions of the software. Generally, however, a worksheet created with a newer version, such as V`7.0`, cannot be read by an earlier version, V4.0.

To read a worksheet file with an earlier version, save the file as the worksheet ASCII format (.DSA). You may have to reconfigure some modules, but the older ***ServiceLab*** is more likely to be able to read the ASCII format worksheet.

6. Display Company Logo

The ***ServiceLab*** logo appears in the Copyright Information dialog box (About ***ServiceLab*** from the Help menu). You can display your company logo by creating the logo as a Windows Metafile (∗.WMF). Copy that file to the ***ServiceLab*** directory as LOGO.WMF. The next time you start ***ServiceLab***, your logo will be displayed in the Copyright Information window. It may be necessary to fine-tune the size and proportions of the picture.

Appendices

A: What's Included in Your *ServiceLab* Package

The ***ServiceLab*** package consists of the following parts:

- CD-ROM with the installation files for the ***ServiceLab*** program files, the setup program files
- Registration card and license.
- ***ServiceLab*** user-manual

B: Internal Data Flow and Precision Information

Data values are represented in ***ServiceLab*** as single precision floating point values. All calculations except the FFT are carried out in double precision (8 Byte floating point).

Single Precision Format

Data Format:	32 Bit 1 Bit sign 8 Bit exponent 23 Bit mantissa
Range:	3.4E-38 to 3.4E+38
Accuracy:	at least 7 decimals

Double Precision Format

Data Format:	64 Bit 1 Bit sign 11 Bit exponent 52 Bit mantissa
Range:	1.7E-308 to 1.7E+308
Accuracy:	at least 15 decimals

C: ASCII Table

Control Characters (not printable)

Decimal	Octal	Hex	Characters	Code	Notes
0	000	0x00	Ctrl-@	NUL	Null prompt
1	001	0x01	Ctrl-A	SOH	Start of heading
2	002	0x02	Ctrl-B	STX	Start of text
3	003	0x03	Ctrl-C	ETX	End of Text
4	004	0x04	Ctrl-D	EOT	End of transmission
5	005	0x05	Ctrl-E	ENQ	Enquiry
6	006	0x06	Ctrl-F	ACK	Acknowledge
7	007	0x07	Ctrl-G	BEL	Bell
8	010	0x08	Ctrl-H	BS	Backspace
9	011	0x09	Ctrl-I	HT	Horizontal tab
10	012	0x0A	Ctrl-J	LF	Line feed
11	013	0x0B	Ctrl-K	VT	Vertical tab
12	014	0x0C	Ctrl-L	FF	Form feed
				NP	New page
13	015	0x0D	Ctrl-M	CR	Carriage return
14	016	0x0E	Ctrl-N	SO	Shift out
15	017	0x0F	Ctrl-O	SI	Shift in
16	020	0x10	Ctrl-P	DLE	Data link escape
17	021	0x11	Ctrl-Q	DC1	X-ON
18	022	0x12	Ctrl-R	DC2	
19	023	0x13	Ctrl-S	DC3	X-Off
20	024	0x14	Ctrl-T	DC4	
21	025	0x15	Ctrl-U	NAK	Not acknowledged
22	026	0x16	Ctrl-V	SYN	Synchronous idle
23	027	0x17	Ctrl-W	ETB	End transmission blocks
24	030	0x18	Ctrl-X	CAN	Cancel
25	031	0x19	Ctrl-Y	EM	End of medium
26	032	0x1A	Ctrl-Z	SUB	Substitute
27	033	0x1B	Ctrl-[	ESC	Escape
28	034	0x1C	Ctrl-\	FS	File separator
29	035	0x1D	Ctrl-]	GS	Group separator
30	036	0x1E	Ctrl-^	RS	Record separator
31	027	0x1F	Ctrl-_	US	Unit separator
127	0177	0x7F		DEL	Delete or rubout

Printable Characters:

Decimal	Character	Decimal	Character	Decimal	Character	Decimal	Character
32:		33:	!	34:	"	35:	#
36:	$	37:	%	38:	&	39:	'
40:	(	41:	)	42:	*	43:	+
44:	,	45:	-	46:	.	47:	/
48:	0	49:	1	50:	2	51:	3
52:	4	53:	5	54:	6	55:	7
56:	8	57:	9	58:	:	59:	;
60:	<	61:	=	62:	>	63:	?
64:	@	65:	A	66:	B	67:	C
68:	D	69:	E	70:	F	71:	G
72:	H	73:	I	74:	J	75:	K
76:	L	77:	M	78:	N	79:	O
80:	P	81:	Q	82:	R	83:	S
84:	T	85:	U	86:	V	87:	W
88:	X	89:	Y	90:	Z	91:	[
92:	\	93:	]	94:	^	95:	_
96:	`	97:	a	98:	b	99:	c
100:	d	101:	e	102:	f	103:	g
104:	h	105:	i	106:	j	107:	k
108:	l	109:	m	110:	n	111:	o
112:	p	113:	q	114:	r	115:	s
116:	t	117:	u	118:	v	119:	w
120:	x	121:	y	122:	z	123:	{
124:	|	125:	}	126:	~	127:	□
128:	€	129:	□	130:	‚	131:	ƒ
132:	„	133:	…	134:	†	135:	‡
136:	ˆ	137:	‰	138:	Š	139:	‹
140:	Œ	141:	□	142:	Ž	143:	□
144:	□	145:	‘	146:	’	147:	“
148:	”	149:	•	150:	–	151:	—
152:	˜	153:	™	154:	š	155:	›
156:	œ	157:	□	158:	ž	159:	Ÿ
160:		161:	¡	162:	¢	163:	£
164:	¤	165:	¥	166:	¦	167:	§
168:	¨	169:	©	170:	ª	171:	«
172:		173:	-	174:	®	175:	¯
176:	°	177:	±	178:	²	179:	³
180:	´	181:	µ	182:		183:	·
184:	¸	185:	¹	186:	º	187:	»
188:	¼	189:	½	190:	¾	191:	¿
192:	À	193:	Á	194:	Â	195:	Ã
196:	Ä	197:	Å	198:	Æ	199:	Ç
200:	È	201:	É	202:	Ê	203:	Ë
204:	Ì	205:	Í	206:	Î	207:	Ï

Decimal	Character	Decimal	Character	Decimal	Character	Decimal	Character
208:	Ð	209:	Ñ	210:	Ò	211:	Ó
212:	Ô	213:	Õ	214:	Ö	215:	×
216:	Ø	217:	Ù	218:	Ú	219:	Û
220:	Ü	221:	Ý	222:	Þ	223:	ß
224:	à	225:	á	226:	â	227:	ã
228:	ä	229:	å	230:	æ	231:	ç
232:	è	233:	é	234:	ê	235:	ë
236:	ì	237:	í	238:	î	239:	ï
240:	ð	241:	ñ	242:	ò	243:	ó
244:	ô	245:	õ	246:	ö	247:	÷
248:	ø	249:	ù	250:	ú	251:	û
252:	ü	253:	ý	254:	þ	255:	ÿ

D: Error Messages and Troubleshooting

The following error messages may be encountered while using ***ServiceLab***.

Analog output had to be interrupted

Cause	the D/A buffer is empty, ***ServiceLab*** could not generate data to be sent by the D/A module fast enough
Correction	reduce the output rate, or increase the output buffer size

Cannot create DDE Link

Cause	the specified server application is not active or the specified Topic or Theme is not available
Correction	start application and make sure that Topic and Theme are defined

Cannot execute the worksheet at this module - aborted

Cause	the worksheet contains a loop that means the output of a module is (indirectly) needed for its input
Correction	insert a time delay module or remove the loop completely

Cannot open COMx

Cause	the serial port is used by another application under Windows and is not available for ***ServiceLab***
Correction	make sure that the specified COM-port is not used by the mouse or by any other Windows application

DDE Link was interrupted

Cause	the DDE Link was interrupted by the Server program
Correction	make sure that the Server program is still running

Digital output had to be interrupted

Cause	the digital output buffer is empty, ***ServiceLab*** could not generate data to be sent by the Digital Out module fast enough
Correction	reduce the output rate, or increase the output buffer size

Error No 15

This message may occur with some drivers that have not replaced the default message text.

Cause	(and meaning) data acquisition could not be started because a hardware conflict (like interrupts) has been detected. This is a driver error code and you should report this message to technical support for more information. Please be prepared to describe the exact situation in which it occurs.

File read error

Cause the data file you want to read is corrupt or has the wrong file format

Correction check for the correct settings in the dialog box and make sure that the file format is correct

Illegal block size STOP

Cause the FFT related module can only handle block sizes that are a power of 2

Correction use the Data Windows module to change the block size at the FFT input to a power of 2

Output rate does not match the channel rate for one channel. STOP

Output rate does not match the input rate at an input. STOP

Cause these messages indicate that the global acquisition rate is not an integer multiple of the defined output rate. Synchronized output can only be realized in a way that one sample is sent to the D/A Card after a certain number of input samples has been acquired. Therefore the input rate divided by the output rate has to be an integer value. In both cases ***ServiceLab*** does not use the channel rates, but the summed rates.

Correction adjust the analog or digital output rate

The sample frequency is too high for this module

Cause The Chart Recorder does not check the rate of input signals.

Correction slow down the input rate by separate or average modules

The sampling rate is too fast. The measurement has been stopped

Cause the speed ***ServiceLab*** can acquire data from an analog input card is limited. The limits depend on the hardware structure and the computer you use as well as on the worksheet you run. There may be different circumstances causing this message. The most common reason is that the driver buffer in ***ServiceLab*** had an overrun and that the driver did not know where to store the next samples. In this case the measurement is stopped. Usually the bar in the status line indicates how much of the driver buffer is used, there are some situations where there may be no time to update the indicator. Another possible reason is that the interrupt frequency that is needed to acquire data at the desired rate was too high and that ***ServiceLab*** noticed that interrupts have been lost. This may be caused by extreme bus activities of the graphics or hard disk controllers.

When this happens, the message also appears without having the buffer status indicator filled.

Correction slow down the sampling rate or increase the driver buffer

You cannot display signals from these input channels together in one scope

Cause the Y/t Chart module can only display signals of the same type in one display. The same type means that they are all time dependent, all frequency dependent or all histograms. When the signals are time dependent they have to have the same gap structure, that means that they may have gaps, but all at the same time and of the same length.

Correction use the Signal Adaptation module before the Y/t Chart or use different Y/t Charts for the different types

You cannot display signals from these input channels together in one X/Y chart

Cause the X/Y Chart module can only display signals of the same type in one display. The same type means that they are all time dependent, all frequency dependent or all histograms. When the signals are time dependent they have to have the same gap structure, that means that they may have gaps, but all at the same time and of the same length

Correction use the Signal Adaptation module before the X/Y Chart or use different X/Y Charts for the different types

E: Product Support

ServiceLab is an innovative Windows application that has been developed over a period of several years by a team of committed engineers. To ensure that our software product will meet the changing needs of its users, we will continue to develop ***ServiceLab***. If you fill in the registration form included in this package and send it back to us, you will automatically receive the latest information on any updates of the software.

Information about changes or features that were included after this user guide was printed is covered in the README.WRI file on your setup disk. Use Windows "Write" (or a similar word processor) to read this file. Read this file to find out about improvements and about conversions that may be necessary before you can use the latest ***ServiceLab*** version.

If you have any questions, suggestions, or requests regarding the ***ServiceLab*** software and documentation, please contact us – we will be glad to help.

***ServiceLab* support**

Tel. +49-731-98588-792 FAX +49-731-98588-794

email: support@servicelab.info

www.servicelab.info

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ServiceLab 7.0

32-bit version for
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Year 2000 Compliance Statement

ServiceLab **7.0** is Year-2000-compliant. It conforms to the British Standards Institution BSI DISC PD-2000-1 'A Definition of Year 2000 Conformity Requirements' document. Specifically, ***ServiceLab*** will:

- Work correctly for the following the transition from December 31, 1999 to January 1, 2000
- Recognize that 2000 is a leap year;
- Work correctly for all dates in the range January 1, 1980 through December 31, 2037, but not before, and not after
- Read and store dates correctly using its private (.DDF) data format, and store appropriately for other date formats

Risky Applications

Warning:

(1) ***ServiceLab*** is not designed with components and testing for a level of reliability suitable for use in or in connection with surgical implants or as critical components in any life support systems whose failure to perform can reasonably be expected to cause significant injury to a human.

(2) In any application, including the above, reliability of operation of the software products can be impaired by adverse factors, including but not limited to fluctuations in electrical power supply, computer hardware malfunctions, computer operating system software fitness, fitness of compilers and development software used to develop an application, installation errors, software and hardware compatibility problems, malfunctions or failures of electronic monitoring or control devices, transient failures of electronic systems (hardware and/or software), unanticipated uses or misuses, or errors on the part of the user or applications designer (adverse factors such as these are hereafter collectively termed "system failures").

Any application where a system failure would create a risk of harm to property or persons (including the risk of bodily injury and death) should not be reliant solely upon one form of electronic system due to the risk of system failure.

To avoid damage, injury, or death, the user or application designer must take reasonably prudent steps to protect against system failures, including but not limited to back-up or shut down mechanisms.

Because each end-user system is customized and differs from the testing platforms of ***ServiceLab Ltd.*** and because a user or application designer may use ***ServiceLab Ltd.*** products in combination with other products in a manner not evaluated or contemplated by ***ServiceLab Ltd.***, the user or application designer is ultimately responsible for verifying and validating the suitability of ***ServiceLab Ltd.*** products whenever ***ServiceLab Ltd.*** products are incorporated in a system or application, including, without limitation, the appropriate design, process and safety level of such system or application.

Contents

Chapter 1
Introduction

Chapter 1: Introduction

1. Welcome to *ServiceLab*!

This is the second volume of the ***ServiceLab*** User Guide – The Module Reference Guide. It contains complete descriptions of each module, including some guidance on how to use it.

Use ***ServiceLab's*** Online Help system to display information about the operation that you are about to carry out on the screen. It may be unnecessary for you to thoroughly study this printed manual.

If you have upgraded from a previous version of ***ServiceLab***, please review Chapter 1 – Section 4 for information about new and changed features.

The ***ServiceLab*** team will continue to develop ***ServiceLab*** as software that matches its users' requirements and preferences.

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2. About your *ServiceLab* Documentation

2.1. What's Included

The ***ServiceLab*** documentation consists of the following:

- The context-sensitive online Help system provides quick on-screen reference to procedures and commands you may need while working with ***ServiceLab***. In addition, hardware help is provided to describe the installation, setup, and use of your specific data acquisition device.
- The printed or the digital User Guide contains a comprehensive description of all of ***ServiceLab*** functions and their uses. It serves as a reference book, providing background information.
- This printed or digital book, Volume 2 of the User Guide, the Module Reference Guide, with complete descriptions of each Module Group and Module.
- README.WRI, an information file that is copied to your hard disk when you set up ***ServiceLab***, provides information that was updated after this User Guide was printed. You can easily read (or print) this file using Windows Write.

⇨ *We strongly recommend that you read the* ***README.WRI*** *file before you start working with the software.*

2.2. Typographic Conventions

We have used visual cues and standard text formats in this User Guide to help you locate and interpret information easily.

Text Formats

File names and directory names are printed in ALL CAPITALS.

All references to menus, menu commands and to the options available in dialog boxes are printed in this sans serif typeface.

All references to keyboard keys and command entries are printed in `this text format`. These are usually commands that you must type at the DOS Prompt or in ***ServiceLab*** or Windows text boxes exactly as you find them printed in this manual. It does not matter whether you type upper or lowercase letters.

Keyboard Formats

Key combinations and key sequences:

`KEY1+KEY2` means to press and hold down the first key while you press the second.

`KEY1, KEY2` means to press and release the keys one at a time.

Symbols

We have used the following symbols throughout this User's Guide to identify important information to guide you to information on a related topic:

Serious Warning! *Neglecting the hints indicated by this symbol may result in severe program errors or even damage to your hardware.*

Warning*. Neglecting the hints indicated by this symbol may result in* ***ServiceLab*** *not operating properly; data may be misinterpreted or not calculated correctly. This symbol will remind you to check that parameters are set correctly, or to check settings that must match.*

When you have read a passage about a subject, this symbol may indicate that explanations on a related subject can be obtained elsewhere in this User Guide, or that similar commands, options, etc. might be of interest in the current context.

3. *ServiceLab* Versions

ServiceLab is available with optional features. The table below lists the features available. Please contact your dealer or distributor for more information about ***ServiceLab***. Note that this User Guide includes information about optional features.

Optional features may vary by country. Check with your dealer or distributor for details.

The chart below shows the versions and which modules are provided with each version.

Group	Module	Basic Version	Optional
Input/Output	SIMATIC S7 read	X	
	Analog Input		X
	Analog Output		X
	Digital Input		X
	Digital Output		X
	Counter Input		X
	Frequency Output		X
	RS232 Input	X	
	RS232 Output	X	
	ICOMs Input	X	
	ICOMs Output		X
	IEEE488 Input		X
	IEEE488 Output		X
	DDE Input	X	
	DDE Output	X	
	IVI Devices		X
	MODBUS Devices		X
Trigger	Combi Trigger	X	
	Pre/Post Triggering	X	
	Start/Stop Triggering	X	
	Trigger on Demand	X	
	Sample Trigger	X	
	Relay	X	
Mathematics	Formula Interpreter	X	
	Arithmetic	X	
	Trigonometry		X
	Scaling	X	
	Different./Integration	X	
	Logical Operations	X	
	Slope Limitation	X	
	Bit Logic	X	
	Gray Code		X
	Flip-Flop		X
	Channal Comparison	X	
	Reference Curve	X	
Statistics	Statistical Values	X	
	Position In Signal	X	
	Histogram	X	
	Regression	X	
	Counter	X	
	Minimum/Maximum	X	
	Pulse Width Analysis		X
	Sort Channels		X
	Check Reference Curve	X	
Control	Generator	X	
	Switch	X	
	Coded Switch		X
	Slider	X	
	PID Control		X
	Two-Point Control		X
	Time Delay	X	
	Latch	X	
	TTL Pulse Generator	X	
	Global Variable Read	X	
	Global Variable Write	X	
	Signal Router		X
	Blocktime Info		X
	Stop	X	

Group	Module	Basic Version	Optional
Signal Analysis	Filter		X
	Correlation		X
	Data Window		X
	Elektric Characteristics		X
	Harmonic Distortion		X
	Period Check		X
	FFT		X
	Polar/Cartesian		X
Display	Y/t Chart	X	
	X/Y Chart	X	
	Chart Recorder	X	
	Analog Meter	X	
	Digital Meter	X	
	Bar Graph	X	
	Status Lamp	X	
	List Display	X	
Files	Read Data	X	
	Write Data	X	
	Backup Data	X	
	ODBC In	X	
	ODBC Out	X	
Data Reduction	Average	X	
	Block Average	X	
	Separate	X	
	Merge/Expand	X	
	Cut Out	X	
	Shift Register		X
	Time Slice		X
	Circular Buffer	X	
Network	DataSocket In		X
	DataSocket Out		X
Special	Black Box	X	
	Ex/Import Black Box	X	
	Event Driven Actions	X	
	Message	X	
	Send E-Mail	X	
	Time Base	X	
	Signal Adaptation	X	

4. New in *ServiceLab* Version 7.0

Below, you will find an overview of the most important additions and changes for the current ***ServiceLab*** Version. Please also read the README.WRI file for additional changes made after this book was printed.

We have described the most important changes and additions to this ***ServiceLab*** version on the following pages.

4.1. General

Replace Module

You can Replace modules by other modules of similar configuration. Use the new command and select one of the available replacements from the list.

Start-Up dialog for Global Strings / Variables

Use the new Menu Command to configure the order in the list of strings/variables that must be entered at the start of an experiment.

Import Global Strings / Variables

In addition to the *.VAR file format (generated by the global variables export function) now you can import standard file formats *.CSV, *.TXT (Excel format) with the command on the **Options** Menu. For the import an Excel table separated by commas is needed.

In this way you can configure the global variables in an Excel table, where it is easy to create similar configurations with Copy/Paste; ensure that you do not enter the same entries several times into the global variable dialog box.

Action/Layout Link Check

The renaming of modules which are referenced in Action modules or layout links will now be handled appropriately. All action modules and layout objects with references to the renamed module will use the new module name. You no longer have to manually rename these links.

Also, deleting layout pages updates any links in action modules to the new Layout page numbering.

Block Move of Modules and Signal Connections

You can select a block of Modules and move them to another part of the Worksheet. All Connections are also moved.

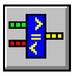
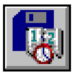
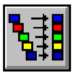
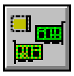
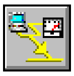
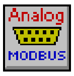
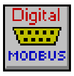
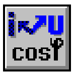
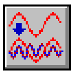
User Defined Colors

If any user-defined colors are used in any dialog, such as for the layout background color, then these colours can be used in all other colour setting dialogs.

4.2. New Modules

See the Module Reference Guide for details of each new module.

Module	Module Group

	Channel Comparator (optional)	Mathematics
	Block Time (optional)	Control
	Shift Register (optional)	Data Reduction
	Multi-Speed Analog Input (optional)	Input/Output
	ICOM Input	Input/Output
	ICOM Output (optional)	Input/Output
	MODBUS Analog Input/Output (optional)	Input/Output
	MODBUS Digital Input/Output (optional)	Input/Output
	Electric Characteristics (optional)	Signal Analysis
	Harmonic Distortion (optional)	Signal Analysis
	Period Check (optional)	Network

4.3. Module Changes

Statistical Values

The new Peak-to-Peak function computes the difference between the maximum and the minimum of a block.

Scaling Module: Unit Conversion:

This new option converts the input value into one of several unit systems ***ServiceLab*** allows you to convert from one measurement system to another without the knowledge of the necessary conversion constant. Conversions are included for temperature, volume, pressure, length, mass, velocity, and more.

RS232 Interface (RS232 Input- and RS232 Output Modules)

Improved debugging and setup features are included in the RS232 monitor. Up to 30.000 characters of text are stored in the internal monitor buffer. The Format String Debugging function is a useful tool for detecting errors in Format Strings or to help in creating a Format String. A basic function of the Format String-Debugging is to mark Parser activities with colored characters. The parser divides the series of characters received into parts corresponding to the settings in the Format String and assigns different colors to each of these elements.

Regression

The performance of the Regression Modules was improved. The block size of an input block does not change, and the computation time per regression calculation was more than halved.

Integration/Differentiation Module

The Differentiation/Integration module now allows a control input to reset the module based on the control signal.

Chapter 2
Module Group Overview

Chapter 2: Module Group Overview

This chapter describes the module groups and provides instruction for how to install, manipulate, and change the parameters of the modules in the worksheet.

1. Module Groups

Use the Module menu functions to select any of the modules provided by ***ServiceLab*** to insert into your worksheet.

Within the Module menu, select a Module Group. A Module Group is made up of a number of modules providing similar functions. The Module menu provides the following module groups:

Chapter 3: Input/Output Module Group

Chapter 4: Trigger Functions Module Group

Chapter 5: Mathematics Module Group

Chapter 6: Statistics Module Group

Chapter 7: Signal Analysis Module (optional)

Chapter 8: Control

Chapter 9: Display

Chapter 10: Files

Chapter 11: Data Reduction

Chapter 12: Special

Chapter 13: Network

2. Modules

Choose a module group to display a submenu with the individual modules belonging to that group.

2.1. Module Symbols

A module represents a functional element in the ***ServiceLab*** experiment setup (worksheet). A worksheet can contain up to 256 modules. Each Black Box module can also contain up to 256 modules, including other Black Box modules.

The **functions** symbolized by the modules provide all the operations required for an experiment,

- From data acquisition (by a data acquisition board) or signal generation (simulated by a virtual generator)

- To data analysis, evaluation and processing (mathematics, statistics, control, trigger and other functions)
- Up to their presentation on screen (display instruments) or export for documentation purposes (printer, metafile, etc.).

Each of the available modules in ***ServiceLab*** is shown in two forms, both indicating the module's function: Module Bar icons and worksheet symbols.

A limited number of module icons can be installed on the Module Bar. They can be placed on the worksheet by a single mouse click on the Module Bar icon. Any module can be installed on the Module Bar, including Black Boxes that you have previously saved.

You can configure the Module Bar according to your specific requirements. You can save various configurations to files for later use. For details, please refer to Chapter 4 of this manual.

2.2. Installing Modules

A module can be installed on the worksheet either by choosing it from the Module menu or by clicking its icon on the Module Bar. Either way, the module will be placed on the worksheet as a module symbol. For modules that provide more than one basic operation, you must also select the function type.

Choose a Module Group from the Modules menu to display a submenu with the individual modules that belong to that group. The submenus list **all** the modules currently available. You can select any of the modules by clicking on its name. If a module is not available in your version of the software it will be gray, and you will be unable to select it.

A worksheet can contain up to 256 modules, including Black Box modules.

2.3. Configuring Modules

Use the **left** mouse button to double-click on the module's worksheet symbol to open the Properties dialog box to configure the module. The following parameters can generally be specified in the dialog box:

- The Module Name,
- A short Description,
- The number of inputs/outputs (up to 16 for most modules).

Once you have activated more than one channel, you can select each of them to display and define specific channel parameters.

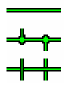
Use the `F7/F8` function keys to easily configure several channels for one module.

For specific module settings, please refer to the individual module descriptions. The general parameters are described in this chapter beginning at page 2-4. The specific module settings are described in the sections for each module.

2.4. Connecting Modules

A data channel is the connection between the output of a module and the input of another module. Data is transferred between modules via these connections.

In the ***ServiceLab*** work area, lines like the ones shown below show connections, which always connect the output and input symbols of the module symbols. By creating junction points and branches, you can connect each module output to up to 16 inputs of other modules.



Data channel

junction points and branches

***no** connections*

For details on how to create, delete and rearrange data channels and branches, refer to Chapter 3 of the User's Guide.

To get further Information about the connected modules while the experiment is runnig:

- *hold the CTRL key while you left click on the data channel*
- *hold the STRG key while you left click on the date channel or*
- *you left click on the data channel.*

2.5. Moving Modules

A module can be moved to any position on the worksheet by dragging and dropping its worksheet symbol. Click on the worksheet symbol with the **left** mouse button and, while holding the mouse button down, drag it to any position. When the mouse button is released, the module symbol will automatically be aligned based on the spacing value entered in the Window Setup box of the Options menu.

You can move a group of modules together if the data lines do not have any data branches. Click and drag the mouse to draw a selection frame around the modules. All modules within this range will be marked and can be moved together. Use Ctrl-Click to deselect modules that you do not want to move.

2.6. Select Modules

Click on the worksheet symbol with the **left** mouse button or draw a box around the module (or modules) while holding the mouse button down. All modules within the frame will be selected.

2.7. Copy Modules

Selected modules can be copied using the Main Menu command Edit: Copy.

2.8. Paste Modules

Selected modules can be pasted into the worksheet using the Main Menu command Edit: Paste.

2.9. Deleting Modules

Modules can be deleted by double-clicking the worksheet symbol with the right mouse button. This opens a dialog box allowing you to remove the module or to delete its input or output connections. Modules also can be deleted using the Edit command of the Main Menu.

2.10. Replace Module

You can replace a module in your worksheet by another module of the same type of functionality. Right mouse click on the module symbol to open the module context menu. Use the Replace Module command to open a list box with all available replacements. If you replace the old module with the selected new module, all input and output lines are preserved. You can copy over both the **channel names** and the **units** defined in the original module.

2.11. Search for Modules

You can search for installed modules with the Search for Modules command. You can select the command from the Edit menu or from the dialog box that appears when you double-click on the worksheet symbol with the right mouse button. The Search for Modules command opens a list box with all installed modules and black boxes. When you double click with the left mouse button on the desired module, ***ServiceLab*** jumps to the module icon in the worksheet.

Some of the operations described here can also be performed using the keyboard. See page 2-11 for more information on keyboard operations.

3. General Module Parameters

3.1. Module Name

To clearly identify a module on the worksheet, enter an identifying name for each module. The name may consist of up to 12 alphanumeric characters. ***ServiceLab*** provides a default name, which you can change to clearly document the function of the module in your experiment.

The module name will be shown in the Title Bar of the module symbol. With modules that provide an additional display or control window, such as the display modules, the identifier will also be displayed in the Title Bar of the corresponding window and below the icon that represents the minimized window.

Modules that influence the functions of other modules (such as the Action module) identify their target module through its module name (not through data channels as it might appear). For that reason, module names must always be unique.

Whenever you install a new module, ***ServiceLab*** suggests a default name. This name is always unique. It indicates the module function followed by the consecutive number of this module type (for example, Generator00 for the first Generator module, Generator01 for the second Generator module, Generator02 for the third and so forth). The description of the module function may be abbreviated because of the limited number of characters.

3.2. Module Description

Describe the function of each module in the worksheet with up to 40 alphanumeric characters. It will be stored with the worksheet. By default, this field is empty.

3.3. Selecting the Number of Channels

Use the Channel Selection Bar to specify the number of signal inputs and outputs for a module in your worksheet.

This is an essential part of the module configuration. The module symbol in the work area will display the defined number of input (I) and output (O) symbols. These are the starting and termination points for the data channels through which data will be transferred between the modules.

Once you have **activated** more than one channel, you can **select** each of them to display and define **channel-specific** parameters.

Each activated channel can be selected to define and display specific channel parameters.

The buttons described below allow you to easily configure a module.

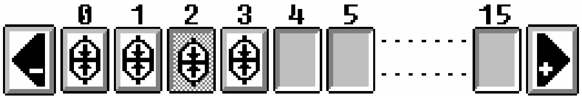
Types

There are three types of Channel Selection Bars:

- The Channel Number Selection Bar is found in almost every Module Configuration dialog box.
- The Input Channel Selection Bar and the Output Channel Selection Bar activate and deactivate the channels on your data acquisition hardware. They are only required in the Module Configuration dialog boxes of those modules from the Input/Output module group which establish the connection between ***ServiceLab*** and your hardware.

Channel Number Selection Bar

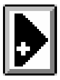
Use this bar to specify the number of signal inputs and outputs of a module in your worksheet. The corresponding module symbol in the work area will then display that number of input (I) and output (O) symbols.



Channel Number Selection Bar (Example)

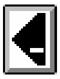
Once you have activated more than one channel, you can select each one to display and define specific channel parameters.

Use the "+" and "–" buttons on the left and right of this bar to increase or decrease the total number of input/output channels of a module. (This can be done only using these buttons.)



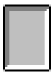
Add One Channel
Click this button to activate one more channel and thus add another input/output to the module. If the maximum number of channels has been activated, the Add Channel button remains gray.

If the newly activated channel had been used before in the same worksheet, its settings will still be valid as **last** selected, as long as the experiment setup has not been saved to a file in the meantime. Otherwise the default values of that module will be used.

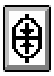


Remove One Channel
Click this button to reduce the number of channels by one. If only one channel has been activated, the Remove Channel button remains gray. If the channel that is to be removed is presently selected, the next channel on the left will be automatically selected. The settings of the removed channel are retained until the worksheet is saved to a file.

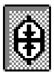
The state of each channel is indicated by one of the following symbols:



Channel inactive
This channel is inactive and cannot be selected. To activate it, click the Add Channel button as described above.



Channel active
This channel is active. The corresponding module symbol on the worksheet supplies an output symbol for this channel. Click the icon with the **left** mouse button to select the channel to define specific parameters. The channel can only be removed by clicking the Remove Channel button as described above.



Channel active and selected
This active channel is currently selected. The settings displayed in the Module Configuration boxes (such as the channel name) all apply to this channel, and it is the only channel that can have parameters defined. You can only deselect this channel by selecting (clicking) another activated channel, or by removing it as described above.

Other channels that are activated though not selected and displayed may be configured differently. To display the settings of any channel, you must select it first.

Configuring several channels for one module is easy when you use the F7/F8 function keys (see page 2-11).

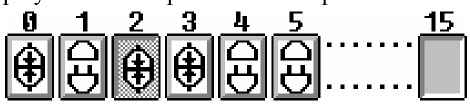
Input and Output Channel Selection Bars

Activate or deactivate the individual input or output channels of the Analog Input, Digital Input, Counter Input, Frequency Output, and Analog Output or Digital Output module using the Selection Bar. The corresponding module symbol in the work area will then display that number of output (O) (for input modules) or input (I) (for output modules) symbols.

You can activate or deactivate more than one channel simultaneously. Press the CTRL key and select the channel up to that you want to activate the channels by **double clicking** the **left mouse button**. All channels between the active and the selected one will be activated. To **deactivate** more than one channel at one time, select the first channel and with the CTRL key pressed, select the last channel to be deactivated. All channels between the channels will be deactivated.

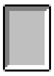
The numbered connector symbols displayed in the horizontal bar represent the physical input or output channels on your data acquisition hardware.

If you have activated more than one channel, you can select each of them to display and define specific channel parameters.

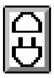


Input or Output Channel Selection Bar (Example)

The state of each channel is indicated by one of the following:



Channel not available
These channels are not available on the data acquisition board installed in your system and cannot be activated or selected.



Channel inactive
This channel is available on the data acquisition board, but it is inactive and will not acquire or output data. Double-click the icon with the **left** mouse button to activate and select it.

Channel active
This channel is active and data will be acquired or output by the hardware when the measurement begins. The module symbol on the worksheet has an output symbol for this channel. Click the icon with the **left** mouse button to select the channel to define specific parameters. Double-click the icon with the **right** mouse button to deactivate the channel.

Channel active and selected
The settings displayed in the Module Configuration boxes (such as the channel name) all refer to the active, selected channel, and it is the only channel that can have parameters defined. You can only deselect this channel by selecting (clicking) another activated channel, or by removing it as described above.

3.4. Channel Name

Type a name for the currently selected channel using up to 20 alphanumeric characters and/or spaces.

Whenever a new channel is activated or existing channels are combined with others, the program provides a default Channel Name. This default name expresses the module function, followed by consecutive numbers (for example: Generator 1, Generator 2, Arithmetic11, Arithmetic12 and so forth).

If the checkbox before the name is activated, the user can change the default name. If the checkbox is not selected (default setting), the name of the connected input (parent) module is copied as the name for each channel when measurement starts. (You can disable this default setting in the Options: Window Setup menu.)

- ***ServiceLab*** can only number the Channel Names within one module. Hence, these default suggestions are not always unambiguous, but can occur repeatedly, especially within more complex worksheets.
- The Channel Name displayed (or modified) in the module configuration dialog box refers to the currently selected channel.
- If you press the F7/F8 function keys to copy parameters, the channel name of the selected channel will be copied to all of the other activated channels. It will thus lose its identifying quality.
- Modules that influence the functions of other modules (such as the Action module) do **not** identify their target channel through its channel name but through its number. For that reason, channel names need not always be unique.

3.5. Channel Units

All data generating Modules have a list box in which you can edit or select the unit used in the selected channel.

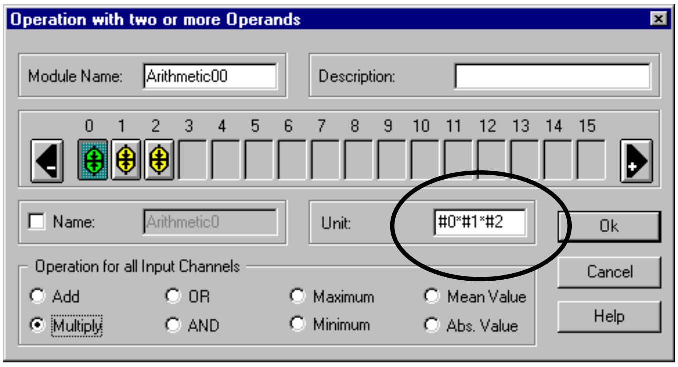
Modules that transfer data without performing a mathematical operation that affects the unit are able to copy the units used in the connected input module. To

copy the units, use the placeholder **#0** in the unit field. You also can use another unit in the edit field, which is then used in this channel and any connected channel in subsequent modules.

Modules (i.e. Arithmetic), which perform mathematical operations, convert the unit as described in the mathematics rules. Obviously, addition and subtraction operations will not change the unit.

If you want to add or subtract two channels with different units, the unit of the first channel is used. A coefficient of one of the units (i.e. 1000 between Millivolts and Volts) is not automatically considered. So summation of the first channel with a 1-Volt signal and a second channel with 1 mV results in 2 Volts. Use the Scaling Module to adapt the second channel to the first.

For example, in an Arithmetic Module, the output is the product of the input channels:



With Integration**,** the unit result is **#0*s**, with Differentiation the result is **#0/s**.

Some data processing modules, such as the Formula Interpreter module, have a list box where you can select or edit the unit.

Display modules or data sink modules (i.e. the Write Data modules) also have an edit field where you can select or edit the channel unit.

Additionally these modules are able to simplify the units if the placeholder (**#0**) is used. You can define up to 30 unit relationships in the ***SERVICELAB*** `.INI` file. The entry has to be as follows:

> The first entry is the simplified unit followed by a line and the greater-than (->) symbol. Then the base units with their mathematical relation follow (i.e. W->V*A). You are not allowed to use already simplified units in the base unit term. Incorrect: J->W*s, correct J->V*A*s. Also only one dividend and one divisor are allowed. If there are several factors you must use brackets around them. (I.e.: N->kg*m/(s*s) but not->kg*m/s*s or kg*m/s/s).

Units used in these modules are divided into the base units and, if possible, abridged as described in the relationships. Then the resulting unit is summarized depending on the defined relationship. (I.e.: W/C => (V*A)/(A*s) => V/s = Wb).

If you don't define any relationships in the ***SERVICELAB*.INI,** the default settings are used.

Hz->1/s	(Frequency: Hertz)
Ohm->V/A	(Resistance: Ohms)
S->A/V	(Electrical Conductivity: Siemens)
W->V*A	(Power: Watts)
C->A*s	(Charge: Coulombs)
Wb->V*s	(Flux magnitude: Webers)
F->A*s/V	(Capacity: Farads)
T->V*s/(m*m)	(Flux Density magnitude: Tesla)
H->V*s/A	(Inductivity: Henry)
N->kg*m/(s*s)	(Force: Newton)
J->V*A*s	(Work: Joule)

You can define up to 30 additional relationships of units in the ***SERVICELAB*.INI** file. Please pay attention to the correct syntax.

4. Special Module Functions and Options

4.1. Modules with Multiple Function Types

Several modules can be operated using different functions.

- In the Module menu, these modules are listed showing only their basic function and the Module Bar symbol only presents this function, for example, Arithmetic.
- Once installed on the Worksheet, one type of this module is shown and it can only execute one of the various functions.

When you insert this type of module into a worksheet you are asked to select the function type. Since the function types often differ with regard to the required number of the inputs and outputs and their assignments, the selection will also determine the basic channel configuration of the module. In addition, the function types may feature various setting options.

Once the module has been inserted into the worksheet, double-click on the Module symbol to show the appropriate Module Configuration dialog box.

You cannot change the function type of a module once it has been inserted onto the worksheet. To change the present configuration you must first delete all data channel connections to this module. Then delete the module itself. Then re-insert the module with another specified function type.

4.2. Module Option: Copy to Outputs

The modules of the Display group, as well as the Write File and DDE Output modules, feature the option Copy Inputs To Outputs. This option provides an

output for each input of the module, and the input data is passed ***unchanged*** to the output for further processing on the worksheet.

- If the output signals of one module are to be used by several other modules, without this function all downstream modules must be connected individually to the source outputs. For this, data channel branches must be created, complicating the worksheet significantly.
- With this function, the data can be used in one module (e.g. displayed), and then the data can also be passed through to downstream modules without any alterations. The worksheet remains legible because a linear worksheet layout can be maintained without a minimum of data channel branches.

This option is useful for connecting several modules with multiple inputs and outputs. On the other hand, the option should **not be used too frequently, since it will affect performance**.

4.3. Module Manipulation by Keyboard

Select the module to be manipulated. It can be identified by the inverse coloring of its title bar.

- To select a module, either click it once with the **left** mouse button, or press the `TAB` key on your keyboard until the desired module is selected (highlighted).
- Press the `ALT+ENTER` keys and the Module Configuration dialog box appears. Then, press the `TAB` or the `SHIFT+TAB` keys to move from one field or button to another; select items by pressing the `ARROW` keys, the `SPACE` and the `ENTER` key. You can only use the mouse to select a channel.
- To copy one parameter, or all the parameters, from the selected channel to all the other activated channels, you can use the `F7` or `F8` function keys (see page 2-11).
- To delete the selected module from the worksheet, or to delete all the input and/or output channels of that module, press the `DEL` key. In the dialog box, select the desired option, or choose Cancel, and press `ENTER`.

4.4. F7/F8 Function Keys

With most modules, up to 16 input/output channels can be activated. Since it can be tedious to set their parameters individually, simplify that task by pressing the **`F7`** or **`F8`** function keys to copy parameters from the selected channel to all the other activated channels:

- **`F7`** to copy only the selected parameter (the currently highlighted one).
- **`F8`** to copy all the parameters of the selected channel – **including** the channel name.

While an experiment is running, you cannot use these function keys.

4.5. Module Info

When you hold down the **CTRL key** and **click the left mouse button** on an output channel of a module, an information window will appear with **online** information about the connected module. The box contains information including the block size, sampling rate, actual data value, connected modules, channels etc. This box is useful when testing new flowcharts.

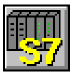
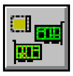
If you **click with the left mouse button** (without any other key pressed) on the data channel, the Info window will be reduced and displays just the Block size, Sampling rate and actual value.

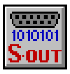
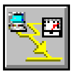
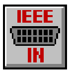
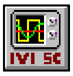
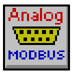
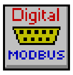
If you click with the **Shift key** pressed, a "graphical" Info window is shown that displays the data block as a chart. The chart is automatically scaled to the maximum and minimum value of the block.

Chapter 3
Input/Output

Chapter 3: Input/Output Module Group

This group consists of the modules that input or output data via supported hardware devices, the serial port, an IEEE488 (GPIB) port, or to other programs using DDE.

	Module	Basic version	optional
	**SIMATIC S7 reading**	x	
	**Analog Input**		x
	**Analog Output**		x
	**Multi-Speed Analog Input**		x
	**Digital Input**		x
	**Digital Output**		x
	**Counter Input**		x
	**Frequency Output**		x
	**DDE Input**	x	
	**DDE Output**	x	
	**RS232 Input**	x	

	**RS232 Output**	x	
	**ICOM Input**	x	
	**ICOM Output**		x
	**IEEE488 Input** INES IOtech National Instruments		x
	**IEEE488 Output**		x
	**IVI Scope**		x
	**IVI Function Generator**		x
	**IVI DMM**		x
	**MODBUS Analog In-put/Output**		x
	**MODBUS Digital In-put/Output**		x

1. SIMATIC S7 Input

This module is used for reading process variables from a SIMENS SIMATIC S7 *(SIMATIC S7-300 or –400) via* **MPI** *or* **PROFIBUS.**

Input and Output Characteristics

Number of Inputs: ---
Input Block Size: ---
Number of Outputs: up to 16
Output Block Size: 1
Max. Number of Modules: 32

In the worksheet this module con read up to 16 different process variables of a SIMATIC S7 and pass on these values to other modules via data channels. It is also possible to install up to 16 module and work with it at the same time.

⇨ *The* **PROFIBUS** *functionality is only applicable for CPUs that are shipped after 1/1/99.*

⇨ *The* **PROFIBUS** *connection can be established with both, the internal DP-interface or the communication processor. Please note that the access via the DP-Interface is the faster one.*

⇨ *The CPUs do not support multi processor operation via* **PROFIBUS** *at the moment.*

The SIMATIC S7-Module is allowing parallel executing and working of STEP7 and different SIMATIC S7.

The definition of the number of channels and the selection of a channel takes place via the cannel setting strip.

The module can be given a description for documentation purposes. ***ServiceLab*** assigns the module a module name and each channel its own channel name. These settings can be altered freely.

1.1.1 Parameters

- **Memory area in PLC**
  The **memory area** in the RAM memory of a SIMATIC from which the process variable is read is defined here. The **SIMATIC S7 module** can read values from the following data areas of the automation device:
  - Input
  - Output
  - Data block (DB)
  - Bit-Memory
  - Counter
  - Timer

- **Variable type**
  The **variable type** defines the size of the memory rang and the interpretation of the process variable which is to be read.
  The following alternatives are available for selection:

  Variable type **Explanation**

Binary	One bit of a process variable (digital value). Binary values are standardised to TTL level at the output of the SIMATIC S7 module, i.e. if the corresponding bit is set in the SIMATIC S7, the value 5 is present at the output of the SIMATIC S7 module, otherwise the value 0.
Byte	8-bit value with range of values between 0 and 255
Unsigned word	16-bit value with range of values between 0 and 65.535
Signed Word	16-bit value with range of values between –32.768 and 32.767
Word in BCD	16-bit value with range of values between –999 and 999
Unsigned double word	32-bit value with range of values between 0 and 4.294.967.295
Signed double word	32-bit value with rang of values between –2.147.483.648 and 2.147.483.647
Double word in BCD	32-bit value with range of values between –9.999.999 and 9.999.999
Floating-point value	32-bit floating-point variable in *IEEE 754* format
Counter value	16-bit value; the counter reading is coded in BCD in bits 11 ... 0. A counter reading can have the values 0 ... 999.
Timer value	16-bit value; the time value is coded in BCD in bits 11 ... 0. A time value can have the values 0 ... 999.

- **Data block**

  This selection box is only available if the **memory area in the PLC** of the process variable which is to be read is a **data block (DB)**.

  Select the number to the data block in which the process variable lies here. But it is only possible to select numbers if data blocks are be read.

- **Address**

This entry defines the **address** within a memory area in the PLC of the process variable which is to be read. If the data area is a **data block (DB)**, the number of the data word which is to be read is to be entered here.

- **Bit**

  This selection box is only available if the **variable type** of the process variable is a binary value. Select the desired bit here. Depending on the addressing of the selected **memory area in the PLC** (8-bit limits) a selection can be made here from bit 0 ...bit 7.

Selection made

- **Process variable**

  This text field is not editable. It provides information on the selected process variable in **STEP 7** notation.

Value range or scaling

Minimum and **Maximum** determine the range of the process variables. **Maximum** and **Minimum** are not editable for the variable type floating-point value. In all other cases, a linear scaling is carried out if the default values in **Minimum** or **Maximum** are changed.

Setting up the interface

The link between Programming Device (PG) or PC and the **SIMATIC S7**, is defined in the three selection windows (Combo-Box) **MPI Address**, **Slot Number and Rack Number**. These interface parameters are valid for only one **SIMATIC S7** module in the ***ServiceLab.***

- **MPI/PROFIBUS Address**

  Select here the MPI- or PROFIBUS-Address of the PLC, which you want to access. The MPI-address 0 is used or the Programming Device.

- **Slot Number**

  Select here the number of the slot, where the CPU is plugged in the rack. Usually it is not necessary to change the default number. If you use a S7-400 for example, you have the change the default settings from: **Slot Number: 2** to **Slot Number: 3**.

- **Rack Number**

Select here the number of the rack you want to access. In this moment the settings will be ignored. You may not change the default settings. This selection window will be used in future developments in the area for **SIMATIC**.

2. Analog Input Module (optional)

Use this module to connect ServiceLab and the analog input channels of the installed data acquisition hardware.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16 (depending on the data acquisition hardware)
Output Block Size:	same as global block size
Max. Number of Modules:	32

ServiceLab supports up to **512** analog input channels in the full version and up to **32** in the limited version.

The module uses the data acquisition driver to access the hardware. Data will be acquired by the data acquisition device and sent to the module. If the selected driver supports more than one hardware component, a Hardware Selection window displays the available hardware. Select the hardware from the list to assign it to the new module.

Kommentar: Full, Sampler, Limited editions?

ServiceLab supports up to **512** analog input channels in the full version and up to **32** in the limited version.

The module uses the data acquisition driver to access the hardware. Data will be acquired by the data acquisition device and sent to the module. If the selected driver supports more than one hardware component, a Hardware Selection window displays the available hardware. Select the hardware from the list to assign it to the new module.

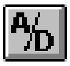
Kommentar: Full, Sampler, Limited editions?

Each module can acquire up to **16** analog signals that are provided to the worksheet through separate signal channels. The number of channels that can be activated is limited by the hardware specifications.

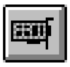
Use the channel bar to activate as many channels as are available. However, you can only select one of them at a time to define the input range and to enter a channel information string. To configure the number of channels, see page 2-2.

Each activated analog input channel provides one output, through which the measured values are sent to the other modules in the worksheet.

2.1. Module Configuration



Click this icon (or choose the Experiment Setup command from the Experiment menu) to open the Experiment Setup dialog box, to define global sampling rate, block size, and other important data acquisition parameters that are explained in Chapter 4 of the User Guide.



Click this icon to open the Hardware Setup dialog box. The settings are specific to the data acquisition device you specified when installing your ***ServiceLab*** version. The settings are explained in Chapter 4 of the User Guide. Please see the Hardware Manual or Online Hardware Help for specific information on your hardware.

2.2. Channel Setup

If your hardware provides additional channel dependent features, these can be specified in a separate dialog box that opens when you click on the Channel Setup button. You will find help on these settings when you choose Hardware from the Help menu. The Channel Setup button remains gray and cannot be activated if the hardware driver does not provide such settings.

Use the Input Channel Selection Bar (see page 2-7) to specify which of the input channels on your hardware are to be active during an experiment. You can activate as many channels as are available.

Each activated input channel increases the number of module outputs so that each channel can send its data to another module through a separate line. You can individually select each channel to define a channel information string, and its input range.

2.3. Scaling

Use the scaling function (Use scaling) to specify channel-specific linear scaling with two points of the input signal. The Scaling button opens a dialog box to activate scaling and specify the settings.

The data acquisition hardware input is converted to the sensor range using these settings. You can define a unit for the Sensor, which is then transferred to subsequent modules in the worksheet.

To define the scaling function:

- Select Use Scaling.
- Select the desired Hardware and Sensor Units.
- Insert the known points of comparison in the Assignment area.
- Close the dialog box by clicking the OK button.

For example, you want to convert the received values to the input values of a pre-amplifier connected before the acquisition board. You know that the **0 V** value on data acquisition board corresponds to **0 mV** at the pre-amplifier. Also,

you know that **10 V** corresponds to **1 mV**. Choose the dialog box settings as follows:

- Activate Use scaling.
- Units: Hardware: *V* Sensor: *mV*
- Assignment: First line Hardware value**:** ***0***, Sensor value**:** ***0***
- Second line Hardware value**:** ***10***, Sensor value**:** ***10***

2.4. Channel Information

For each channel, enter additional information of up to 100 alphanumeric characters into the channel information field. For example, you might wish to describe the function of each channel.

The Channel Information will be saved with the worksheet configuration. There is no default setting for this field.

2.5. Input Range

Many data acquisition devices provide selectable input ranges and an integrated programmable gain.

- The selectable Input Range usually defines the input range of all the activated channels of the device. If the hardware supports this option, the range can be selected in the Hardware Setup dialog box.
- If the data acquisition hardware installed in your system is equipped with a programmable gain, you can select the input range for each channel in the Analog Input module.

*The Input Range entered in the **ServiceLab** dialog box must correspond exactly to the hardware configuration to ensure correct data processing by **ServiceLab**. For information on jumper and DIP switch settings on your hardware please choose Hardware from the Help menu.*
If your data acquisition hardware does not provide amplification, this box displays the range selected in the Hardware Setup dialog box. This value cannot be changed.

For further information on your hardware, choose Hardware from the Help menu, or refer to your Hardware Manual.

3. Multispeed Analog Input Module

Some drivers (Measurement Computing, ADLink etc.) can access the Analog Input channels using the Analog Input Multi-Speed module. If the installed driver allows this function, the Hardware selection dialog shows the available hardware. Otherwise, you will receive an error message that this module is not supported by the installed driver. If you installed one of these drivers with your ***ServiceLab*** version you can access the hardware help file by clicking on the Help button in the Multi-Speed Analog Input module properties dialog box.

This new set of drivers allows you to specify an individual sampling rate and block size for each of the installed DAQ boards. The DAQ Analog Inputs will work independently in one experiment worksheet.

If you are not using one of the Multispeed drivers, you cannot create the *Analog Input Multi-Speed* module.

4. Analog Output Module (optional)

Use this module to define analog output channels that are available on the installed data acquisition hardware.

This module can take up to 16 signal lines and connect them to the analog output channels of the installed hardware. The number of channels that can be activated is limited by the hardware specifications. If the selected driver supports more than one hardware component, a Hardware Selection window opens with a list of available hardware. Select the hardware from the list to assign it to the new module.

This module is useful if your application requires experiment control or the output of analog data for stimulation.

Input and Output Characteristics

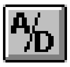
Number of Inputs:	up to 16 (depending on the data acquisition hardware)
Input Block Size:	same as global block size
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	2

This module represents analog output channels if they are available on the installed data acquisition hardware. ***ServiceLab*** supports up to **32** analog output channels in the full version and up to **16** in the basic version.

Use the Output Channel Selection Bar (see page 2-7) to specify which of the output channels on your hardware are to be active during an experiment. You can activate as many channels as are available on the hardware.

Each activated output channel increases the number of module inputs, so that each channel can receive data from other modules through a separate line.

It is possible to reset each output channel to a defined value when the measurement stops. The value is defined in the input field at the bottom of the box.



Click on this icon (or choose the Experiment Setup command from the Experiment menu) to define the Output Mode and other output parameters. For details, see Chapter 4 of the User Guide.

5. Digital Input Module (optional)

Use this module to acquire digital input signals with the corresponding digital I/O of the installed data acquisition hardware.

Up to 16 digital signals can be acquired and provided to the worksheet through separate signal channels. The number of channels that can be activated is limited by the hardware specifications.

If the selected driver supports more than one hardware component, a Hardware Selection window opens, displaying the available hardware. Select the hardware from the list to assign it to the new module.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16 (depending on the data acquisition hardware)
Output Block Size:	any
Max. Number of Modules:	32

ServiceLab supports up to **512** digital input channels in its full version and up to **16** in the basic version. This module uses the data acquisition driver to access the hardware. Data is acquired by the data acquisition device and sent to the module.

The digital signals are usually acquired at the global sampling rate. Its values in ***ServiceLab*** are set according to the TTL definition (0 for low and 5 for high).

Some drivers allow digital and counter input only in asynchronous mode. This is due to the transfer method used. With those drivers typically one digital or counter value is read for one complete block of analog data. The digital and counter input rate thus differs by a factor equal to the global block size. The timing of digital and counter input is not exactly equidistant, which may cause jitter errors.

The Separate Handling of Digital Bits Option switches between single processing of the digital bits and group processing.

- If the option is active, each active bit is processed as a separate channel using TTL levels where 5.0 represents the set bit and 0.0 represents bit reset. The module has one channel for each activated bit.
- If the option is disabled, all activated bits are simultaneously processed as a digital word**.** In this mode, the module has only one channel for all bits, independent of the number of activated bits.

For each activated digital input channel the module provides one output, through which the measured values will be sent to other modules in the worksheet.

Module Configuration

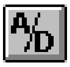
Double-click on the module symbol in the worksheet to open the Module Configuration dialog box.

Use the Input Channel Selection Bar (see page 2-7) to specify which of the input channels on your hardware are to be active during an experiment. You can activate as many channels as are available on the hardware.

Each activated input channel increases the number of module outputs so that each channel can send its data to another module through a separate line, if you have chosen the Separate Handling of Digital Bits option. Otherwise the module has one output.

Use the Bit Operations module (see page 5-13) to operate on the digital word, to separate out one or more bits as individual channels, or to combine individual channels together as a digital word. You can also use the Status Lamp module (see page 9-36) to display the Digital word as individual bits.

You can select each channel to define specific channel settings.



Click this symbol (or choose the Experiment Setup command from the Experiment menu) to open the Experiment Setup dialog box, where you can define the global sampling rate, the block size, and other important data acquisition parameters. For details, see Chapter 4 of the User Guide.

6. Digital Output Module (optional)

Use this module to set up Digital I/O on the installed data acquisition hardware.

This module can take up to 16 signal lines and connect them to the digital output channels of the installed hardware. The number of channels that can be activated is limited by the hardware specifications.

If the selected driver supports more than one hardware component, a Hardware Selection window opens, displaying the available hardware. Select the hardware from the list to assign it to the new module.

This module is useful if your application requires experiment control or the output of analog data for stimulation.

Input and Output Characteristics

Number of Inputs:	up to 16 (depending on the data acquisition hardware)
Input Block Size:	same as global block size
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	32

Use the Output Channel Selection Bar (see page 2-7) to specify which of the output channels on your hardware are to be active during an experiment. You can activate as many channels as are available on the hardware.

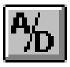
The Separate Handling of Digital Bits Option switches between single processing of the digital bits and group processing.

- If the option is active, each active bit is processed as a separate channel using TTL levels where 5.0 represents the set bit and 0.0 represents bit reset. The module has one channel for each activated bit.
- If the option is disabled, all activated bits are simultaneously processed as a digital word. In this mode, the module has only one channel for all bits, independent of the number of activated bits.

Each activated output channel increases the number of module inputs so that each channel can receive data from other modules through a separate line.

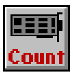
Use the Bit Operations module (see page 5-13) to operate on the digital word, to separate out one or more bits as individual channels, or to combine individual channels together as a digital word. You can also use the Status Lamp module (see page 9-36) to display the Digital word as individual bits.

It is possible to reset each output channel to a defined level (high or low) when the measurement stops. The value is declared in the input field at the bottom of the box.



Click this Function Bar icon (or choose the Experiment Setup command from the Experiment menu) to define the Output Mode, and other important output parameters. For details, see Chapter 4 of the User Guide.

7. Counter Input Module (optional)



Use this module to acquire and count impulses or frequencies. It is available if your data acquisition hardware supports counter measurement.

Up to 16 counter signals can be acquired and provided to the worksheet through separate signal channels. The number of channels that can be activated is limited by the hardware specifications.

If the selected driver supports more than one hardware component, a Hardware Selection window opens, displaying the available hardware. Select the hardware from the list to assign it to the new module.

This module is not included in the basic version.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16 (depending on the data acquisition hardware)
Output Block Size:	same as global block size
Max. Number of Modules:	2 (depending on the data acquisition hardware)

ServiceLab supports up to **32** counter input channels.

The module uses the data acquisition driver to access the hardware. Data will be acquired by the data acquisition device and sent to the module.

Each counter channel will acquire data at the global sampling rate.

The resolution of the timer is 16 bit, with an upper limit of 65535. In ***ServiceLab*** these values are treated as float values (range up to 10^38).

Each activated counter channel will usually acquire data at the Global Sampling Rate.

Some drivers allow Digital and Counter Input only in asynchronous mode. This is due to the transfer method used. With those drivers typically one digital or counter value is read for one complete block of analog data. The digital and counter input rate thus differs by a factor equal to the global block size. Also, the timing of digital and counter input is not exactly equidistant, which may cause jitter errors.

For each activated counter input channel, the module provides one output, through which the measured values will then be sent to the other modules in the worksheet.

Module Configuration

Double-click the module symbol on the worksheet to open the Module Configuration dialog box.

Use the Input Channel Selection Bar (see page 2-7) to specify which of the counter channels on your hardware are to be active during an experiment. You can activate as many channels as are available on the hardware.

Each activated counter channel increases the number of module outputs, so that each channel can send its data to another module through a separate line.

ServiceLab supports up to **32** counter input channels. You can select each of these channels to define further specific channel settings.

ServiceLab provides three different counter modes:

- Single: Each acquired sample represents the counter difference from the preceding value, the number of pulses since the last reading. If a counter is read once per second, the values will directly represent the pulse frequency in Hertz.
- Running: The values are read as in the Single mode, but the driver directly calculates the sum of all the acquired samples. Since ***ServiceLab*** uses float values for the result of summation, the accuracy will be about 6 to 7 digits and the range will be up to 10^{38}.
- Frequency: The values are read as in the Single mode, and the driver then directly converts them into frequency values.

You can switch between modes while the measurement is running. Since the driver calculates the values, the active Running Mode always represents the number of pulses since the beginning of the measurement, even if the mode has been changed.

7.1. Hints for frequency measurement

In frequency measurement, the ***first calculated value may be too small***, nearly half the real frequency

The reason for this behavior is that some data acquisition cards get the measured data in the middle of the sampling intervals not at the end (i.e. a sampling rate with 0.1 Hz starts receiving the data at 5, 15, 25, ... seconds after the start of the measurement. Thus, the counter will get only half as many pulses at the first measured value in comparison with the following measured values. The result is an incorrect first measured value.

Doubling the first value in the driver algorithm is not recommended because the running pulse count would be distorted. Doubling only in frequency mode in the ***ServiceLab*** module is also not possible, because this effect does not happen with all data acquisition hardware. Also doubling would cause an inconsistency between the frequency and single measurement mode.

To fix this problem, you can use the Separate Module in the ***ServiceLab*** flowchart to skip the first sample in the data stream.

8. Frequency Output Module (optional)

Use this module to send frequency data to the Output channels of a connected data acquisition hardware device (plug-in board or other external device).

It can take up to **16** digital signals from the worksheet and connect them to the corresponding hardware output. If the selected driver supports more than one hardware component, a Hardware Selection window opens, displaying the available hardware. Select the hardware from the list to assign it to the new module.

The counters of the board can be activated using the Channel Selection Bar.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	same as global block size
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	2 (depending on the data acquisition hardware)

This module can be useful when you want to generate frequencies based on values at an input channel. You can use these frequency values for stimulation or control of external processes.

The parameters necessary to define the Output Mode can be set in the Experiment Setup dialog box of the Experiment menu.

Depending on the data acquisition hardware used, one or more of the following options are available for Operation Mode:

- Frequency Modulated Square Wave: A square signal is output with a pulse/pause ratio of about 1:1. The module input signal is interpreted as a frequency value in Hertz. The rectangle output is adapted to that frequency. If the installed hardware is not able to create this frequency exactly, the module will automatically choose the next possible frequency.
- Frequency Modulated Impulse: This function is similar to the frequency modulated square wave, but without the pulse/pause ratio of 1:1. The module generates an impulse of a minimum width that depends on the hardware clock.
- Pulse Modulation Duration: A fixed frequency is output with a variable pulse/pause ratio. Set the frequency in the Support Frequency field. If the installed hardware is not able to exactly create the requested frequency, the module will automatically choose the next possible frequency. The module input signal is interpreted as a pulse width in the range of 0 to 100 percent. If the installed hardware cannot exactly output the needed pulse width, the module automatically will choose the next possible pulse width.

This module works asynchronously. Synchronous mode will be implemented in a future version.

It is possible to reset each output channel to a defined value when the measurement stops. The value is declared in the field at the bottom of the dialog box.

9. DDE Input Module

Use this module to receive data from other Windows applications, such as Microsoft Excel. It uses the standard Windows DDE interface (Dynamic Data Exchange).

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	1 or same as global block size
Max. Number of Modules:	up to 16 DDE Input and DDE Output modules

How it works

The DDE Input module can receive data from other Windows applications for up to 16 different channels.

- ***ServiceLab*** supports the DDE System Topic. Other programs that are able to browse DDE Servers to show Service/Topic Combinations will recognize topics that are enabled by ***ServiceLab***. ***ServiceLab*** works as a DDE Server or as a DDE Client with a Hot Link to the DDE Server.
  - If ***ServiceLab*** acts as the Server, the DDE Connection has to be defined by the Sender. First start ***ServiceLab***, and then start the client program.
  - If ***ServiceLab*** acts as a DDE client, the receiving program has to be started first and then the ***ServiceLab*** worksheet can be started. ***ServiceLab*** maintains the DDE link, initiates all data transfers and finishes the communication at the end.
- Data is expected in ASCII format.

Please note that standard DDE operations are always comparatively slow (at a rate of less than 100 Hertz), because all the data is transferred as ASCII strings and must be formatted before use.

Establishing DDE communication

The DDE connection topic specifies whether ***ServiceLab*** acts as server or client. ***ServiceLab*** accepts each appropriate DDE connection.

- If ***ServiceLab*** acts as server, the DDE connection is defined by the sender. The following DDE parameters must be defined in the sending task:

  Application: ***ServiceLab***

  Topic: `DdeData`

  Item: the `Module Name` of the DDE Input module.

When switching to the Server mode all actual entries that are used to communicate with the DDE Client program (the Application, Topic and Item) are displayed. The Browse button opens a dialog box for browsing all DDE Servers that support the System Topic. The chosen entries are imported into the corresponding entry fields when you click the OK button. If the program that you use to communicate with ***ServiceLab*** is able to list all existing DDE Servers, you may then choose ***ServiceLab*** from this list.

- If ***ServiceLab*** acts as a client, the communication must be set up in ***ServiceLab*** in the same way as in the DDE Output module. DDE Connection specifies the receiver of the transferred data. Up to **80** characters can be entered in the Application, Topic and Item boxes.
- In the One item for... area you can select whether the chosen item is valid for all channels or only for the selected channel. If the setting is Each Channel you can use one opened DDE connection to send up to 16 different Items for the chosen Topic. This will save system resources.
- Use Type of items to select fixed or ***ServiceLab*** generated items (e.g. to fill a row, column or matrices in EXCEL, step by step). Because the item generation always depends on the number of the read or written data block, this option is only available with a **Cold Link**.

  If the Generated option is selected, use the Item... button to define the parts of the item that should be generated for DDE transfer (during the measurement) depending on the received number of data block.

  The Item is composed of up to 5 single add-on components (3 fixed text parts and two counters) that are used by the received number of data block. For each counter you can preset a starting value, used at the beginning of measurement, to define after what number of received blocks of data (Increment after) the counter increases with a specified value (Increment by). You can also reset a counter when reaching a specified value (Restart at...). Restart will automatically happen on reaching the value defined as the starting value, but it will also be initialized at each value defined in Restart at....

  There is also a testing mode available: With each parameter change, the calculated item of the set number of block is displayed. The number of blocks may be changed at any time. Use the “+” button to increase the block number by 1. This allows you to check the generated item series in a very simple way. You can also use global variables for all numerical parameters in this dialog box.

Data transfer

The DDE input module receives one sample in each DDE block for each defined channel. The DDE format used is CF_TEXT; space characters must separate the channels and the block should end with a CR/LF character.

If a DDE block contains less than the expected number of channels, the values for all remaining channels are set to 0.

The synchronization specifies the mode for the DDE input module:

- One sample per DDE transfer specifies that the DDE input module will generate one ***ServiceLab*** block of size 1 for each DDE block received.
- Use global settings specifies that the DDE input module will generate a stream of data corresponding to the globally defined sampling rate and block size. The last DDE block received determines the value of the signal. ***ServiceLab*** continuously polls the DDE buffer. If data is sent faster than ***ServiceLab*** polls, intermediate values are ignored. If data is sent slower, some values will be repeated.
- Master DDE sync tells ***ServiceLab*** to try to synchronize the DDE communication by sending an ACKNOWLEDGE message to the sending program after the received block has been processed. Otherwise, a BUSY message is sent. Not all programs react to these messages.

Data format

Decimal format specifies whether a dot or a comma is used as a decimal delimiter.

Net DDE

Programs that are able to use DDE to exchange data running on one machine are also able to exchange data with programs on other machines using an available network.

Structure of data exchange

The DDE Input module receives one value per channel for each incoming DDE Block of ASCII data (format CF_TEXT). *A white space character (blank, semicolon, or tab) must separate channel values.* The end of the block must be a CR/LF character.

When the received number of channels is less than defined in DDE Input module, the values of missing channels will be set to zero. If more channels are received, that data will be ignored.

Synchronization defines how the DDE Input module works:

- The One Block per DDE Transfer mode creates one ***ServiceLab*** data block of size **1** per received data block. You can't process this data with other values.
- In Use Global Settings mode, ***ServiceLab*** will create values with the defined global Sample Rate and Block Size. The last received DDE block

defines the contents of all data channels that are connected directly to other modules.

- With Master of Synchronization**,** ***ServiceLab*** sends an ACKNOWLEDGE signal when the incoming block is finished. Otherwise it sends a BUSY signal. (Note: Most other programs do not support the synchronization protocol.)

When using Global Settings, there will be no different values in single channels in data blocks created by ***ServiceLab****. If incoming DDE data is “too fast,” some data will be lost, because the* ***ServiceLab*** *Dispatcher distributes processor time equally to running modules. If more than one DDE Data block comes in (its contents will be processed directly by the call back function) between two instances of the DDE Input module, all data blocks except the last received block will be lost. That will happen if the relationship between Block size and sample rate is unfavorable (i.e., the distance between two data transfers is smaller than the ratio Block size/sample rate).*

The DDE module always generates constant blocks of data. The sampling rate and block length in ***ServiceLab*** *should be set according to the expected rate of DDE data.*

10. DDE Output Module

This module can be used to transfer acquired or calculated data to any other Windows application supporting the DDE protocol (Dynamic Data Exchange).

This module can take data from up to 16 signal channels and transfer them to any other Windows application.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any, but the same for all the activated channels
Number of Outputs:	same as number of inputs (if option is activated)
Output Block Size:	same as input block size (if option is activated)
Max. Number of Modules:	up to 16 DDE Input and DDE Output modules total

How it works

The incoming samples are transferred to the other Windows application using the DDE protocol.

- If ***ServiceLab*** acts as the Server, the DDE Connection has to be defined by the Sender. First, start ***ServiceLab***, and then start the **client** program.
- ***ServiceLab*** supports the DDE System Topic. Other programs that are able to browse DDE Servers to show Service/Topic Combinations will rec-

ognize topics that are enabled by ***ServiceLab***. ***ServiceLab*** works as a DDE Server or as a DDE Client with a Hot Link to the DDE Server.

- If ***ServiceLab*** acts as the Server, the DDE Connection has to be defined by the Sender. First start ***ServiceLab***, and then start the client program.
- If ***ServiceLab*** acts as a DDE client, the receiving program has to be started first and then the ***ServiceLab*** worksheet can be started. ***ServiceLab*** maintains the DDE link, initiates all data transfers and finishes the communication at the end.

- In the area One item for... you can select whether the chosen item is valid for all channels or only for the selected channel. If the setting is Each Channel you can, with only one opened DDE connection, send up to 16 different Items for the chosen Topic. This will save system resources.
- In Type of items you can select between Fixed and ***ServiceLab*** Generated Items (e.g. to fill a row, column or matrices in EXCEL step by step). Because the generating always depends on the number of the read or written data block, this option is only available with a Cold Link.
- If the Generated option is selected, you can call up a further dialog box, using the button Item.... In this dialog you can define the parts of the Item, which should be generated for DDE transfer (during the measurement) depending on the received number of data block.
- The Item is composed of up to 5 single add-on components (3 fixed parts of text and two counters), which are deduced by the received number of data block. For each counter you can define a starting value, used at the beginning of measurement, to define after what number of received blocks of data (Increment after) the counter increases with a specified value (Increment by). You can also reset the counter when it reaches the Restart at... value. A Restart will automatically happen when reaching the value defined as starting value, but it will also be initialized at each value defined in Restart at....
- There is also a testing mode available: With each change of a parameter the calculated item of the set block number is displayed. The number of block may be changed at any time. Use the "+" button to increase the block number to check the generated series of item in a very simple way. You can also use Global Variables for all numerical parameters of this dialog box.
- All input channels of the DDE Output module must be of the same type, the same sampling rate and the same block size. If this condition is not fulfilled, ***ServiceLab*** displays an error message and the experiment is stopped. The same conditions apply as for the Write Data module in ASCII format.
- ***ServiceLab*** will not start to send data until a complete block of data is available at the module input.

- Data is sent in ASCII format. Details are described below.
- The Copy Inputs to Outputs option provides the module with one output for each activated input. Incoming data is sent unchanged to the output.

⇨ *Please note that standard DDE operations are always comparatively slow (at a rate of less than 100 Hertz), because all the data is transferred as ASCII strings and must be formatted first.*

Net DDE

Programs that are able to use DDE to exchange data running on one machine are also able to exchange data with programs on other machines using an available network (see general hints: DDE).

Definition of the Communication Channel

The DDE Connection entries specify where to send the data. You must specify the Application name, the Topic and the Item. For details of which topics are provided by an application, please check the corresponding documentation.

Data Transfer

Decimal Format defines the format of the data sent by the DDE Output module. The Decimal Delimiter and Number of Decimals can be defined.

ServiceLab sends data in the DDE format CF_TEXT, which means all samples are converted into a block of strings. The maximum size of this string is 65,500 characters. This string contains all data of all input channels for one block of data (on each channel) called the data matrix.

- If the module has more than one input channel, data can be ordered by Row or by Column.
  - If Column is chosen, data is ordered in a way that the samples of one channel form a column in the data matrix.

    The corresponding samples of the connected channels form one row in the data matrix. For a DDE Output module with 2 channels and a block size of 3, ***ServiceLab*** will generate a data matrix of 2 columns by 3 rows.
    An example worksheet for a column-ordered DDE connection with EXCEL is contained in the ***ServiceLab*** directory.
  - If Row is chosen, data is ordered in a way that the samples of one channel form one row in the data matrix.
- Defining the order by Row or Column does not necessarily mean that data is arranged in Rows or Columns in Excel. Excel needs specific delimiters in order to arrange data in the desired way.

Example:

Two channels of data with a block size of 3 are sent by DDE. The Samples of the first channel are named A1, A2, A3 and those of the second

channel are B1, B2, and B3. Ordering by Row means that the DDE block contains the values in the sequence A1, A2, A3, B1, B2, B3. Ordering by Column results in a sequence A1, B1, A2, B2, A3, and B3. All samples are separated by the specified separator. The optional Final Character is inserted after A3 and B3 in the first case and after B1, B2, and B3 in the second case.

- Each row or column can be ended with a CR/LF character.
- In addition to the data, a Time Channel in Microsoft standard format can be sent. Depending on the order, the Time Channel forms the first row or first column of the complete block. You can choose between Time of Day and elapsed Time since Start of the experiment.

Data Format

- Separators

  Delimiters separate the samples in one string. You can choose between Blank, Tab, Semicolon or CR/LF. These separators are only used within one string and are not appended to the end of the string.

  There is an additional option for appending a CR/LF character at the end of each string.
- Decimal Format

  Decimal Format defines the Decimal Delimiter and the Number of Decimals. The actual number of characters depends on the value of the samples and may be different each time. The default decimal delimiter is a comma.

ASCII Format for DDE Output modules

Data samples are sent in the same format as an **ASCII** file.

Several options allow you to modify the standard ASCII format:

- Sort: Sorts data as columns or in line.
- Delimiter: Select a blank, TAB, CR/LF or a semicolon as the delimiter between the channels in each line. You can select that each line will end with a **CR/LF** (CHR13/CHR10) character.
- Decimal Character: Select a dot or a comma as the decimal character.
- Time Column: This option adds a column with time information for each sample.
- Time Format: If Time Channel is activated, select the time channel format here. The following formats are available:

		Example
Elapsed Time [hh:mm:ss]	Elapsed time from start of experiment	00:45:34.20
Time	Actual time	07:30:30.4

[hh:mm:ss]

- Decimals: This parameter determines the number of decimals for the numerical ASCII format.

11. RS232 Input Module

Use this module to scan data coming from devices connected to the PC's serial ports. The module filters the needed values of the arriving data strings based on the module settings and sends them to the module outputs.

This module can read data from up to 16 different channels and transfer them to other modules using its signal channels.

It also can read ASCII strings and write them into a Global String. You can mix value channels and text string channels. Double-click on this module symbol in the worksheet to open the module configuration dialog box, where you can enter the number of input channels available on your hardware using the Channel Number Selection Bar. Each activated Analog Input channel increases the number of module outputs, so that each channel can send its data to another module through a separate line.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16, and, with Slave modules, up to 256
Output Block Size:	1 or global block size
Max. Number of Modules:	up to 8, if the serial ports are available

One RS232 Input module is able to acquire data in up to 16 channels from any serial interface of the PC that is recognized by Windows. (Up to 32 interfaces with the 32-bit version of ***ServiceLab***; up to 10 interfaces with the 16-bit version using Windows 95. All blocks of data are provided with block size and timing information that is necessary to process data in ***ServiceLab.***

When inserting a serial module into the flowchart you can select whether a module is created as a default module (with the usual default settings for all parameters) or as a predefined module with parameters configured for a specific RS232 device. Predefined modules can be selected from the list box. They are created using the menu command Experiment:-> Serial Devices (see Book 1: User Guide: Chapter 4, Section 1.4.11 Serial Devices).

If there is already one serial module in the worksheet, you can add additional Slave modules to the Master module. Each Slave module expands the Master module by up to 16 channels. If you add a new serial module to the worksheet, you must define whether the module will be a new Master module (linked to an-

other serial interface) or will be a Slave module of an existing Master module. If there are several Master modules you can choose between them. The Slave module settings are limited to Get Data and Data Format.

If a Master module is deleted, all assigned Slave modules lose connection. You can no longer use these modules in the worksheet.

The RS232I Input module filters data values from the arriving data strings based on the module settings and sends them to the module outputs. The resulting signal sent to ***ServiceLab*** consists of a number of blocks with different time intervals, with only one data point in each block, and with different starting times. As an alternative, the data can be stored in a separate buffer and can be sent to ***ServiceLab*** with the global acquisition rate and block size. This approach allows an easy synchronization of serial and other data.

ServiceLab holds the COM port open during the time a worksheet with a RS232 module is loaded. When the experiment is started, the serial interface will be closed and re-opened to reset the port parameters and to use the actual module settings. Additionally, this clears the Windows serial buffer, so any data from a previous experiment is lost.

This approach allows the user to prepare worksheets on one computer that may have different serial port settings than the target computer that runs the application.

To check the settings without starting the measurement, use the Send Reset button. This causes the serial port to be closed and re-opened. The defined reset string is also sent.

If the RS232 Input and Output modules use the same serial interface and the input module uses a data request string**,** receiving and sending are completely synchronized, so reading and writing of data via RS232 happens alternately.

11.1. Data Request Command

If the external device needs a data request command, the command string can be defined in this control box. Each channel can be defined separately.

The string is sent to the external device each time ***ServiceLab*** requests data. When you use a device that needs only one string to request a channel list, only define a string for the first channel and leave the others empty.

When there is no request needed (Options Setting) the area is grayed out.

You can use any character in the string except zero (value of byte 0). Use control codes to insert special characters that aren’t directly available via the keyboard. You don’t need Space characters to separate characters. If a space is used in the string, it will be interpreted and sent as a character.

String format for Reset, Start, Stop commands and Data Request

The strings defined in the Options menu are necessary to initialize (reset) the connected external device.

The string can apply to more than one line. This makes the dialog box easier to read, although the `Return` in the dialog box doesn't mean to send a control character. The string can be up to 300 characters long.

A string may contain control characters:

- Hexadecimal: You can use hexadecimal values using **x** followed by two characters to describe a character using a hexadecimal value (Example: `\x0d` = 13 decimal = Return).
- Octal: Octal values are marked with 0 (zero) followed by three numerical characters between 0 and 7 (Example: `\0015` = 13 decimal = Return).
- Predefined: You can use defined control characters preceded by a back-slash (\):

`r`	Return
`t`	Tab (HT)
`a`	Signal (BEL)
`n`	Line Feed (LF)
`b`	Backspace (BS)
`f`	Formfeed (FF)
`v`	Vertical Tab (VT)

You can use one or more pauses between strings. Insert ´`\p`´ at the desired place followed by a time in milliseconds. Because the system time interval is 55 ms, the inserted time will be rounded to the next multiple of this value. If no time is defined, the default time is one second.

The section before first pause will be sent right away. After the defined pause, the next section is sent (up to the next pause or to the end of the string). While sending a string or waiting for the next section of the string, ***ServiceLab*** won't start further actions. The measurement itself won't be influenced because these strings are only sent before starting or ending the measurement.

Example of a correct Reset string:

`\x1b@\r`	Sends the ESCAPE Character followed by the ASCII character @ followed by RETURN.
`\p2000` `RS\r`	Pause for about 2 seconds followed by the text string 'RS' followed by RETURN

Data Format

The serial interface can only receive data in ASCII format. See page 3-33 for details.

11.2. Options

Configuration commands

- Reset Command: This string is sent to the external device each time the worksheet is loaded. It can also be sent by pressing the Send Reset button in the main dialog box. This string is **not** sent automatically when the dialog box is closed.
- Start Command: This string is sent to the external device each time the experiment is started. It may be used to configure the external device for each individual experiment.
- Stop Command: This string is sent each time the measurement stops.

Data Request necessary

- If Yes, ***ServiceLab*** will send the data request string to the external device in intervals defined by the Sample Interval.
- If No, the external device has to send its data without any request and the user cannot define the sampling interval.
- Sample Interval: This option defines the sampling rate independently of the global sampling rate in ***ServiceLab***. Since it uses the PC clock, its resolution is limited to multiples of 55 ms.

  The sampling interval is defined as an interval per channel. If the defined sampling interval is too small for ***ServiceLab*** to process the complete worksheet, the sampling rate is automatically decreased. Useful values for the sampling interval are 0.5 seconds or larger.

Resend Request if Time-out

When this option is enabled, the last data request is repeated if the required samples are not received after twice the sampling interval. The timing of the received data is corrected according to the real acquisition time.

Data Synchronization

In most cases, data sent via RS232 isn't very fast or absolutely equidistant. ***ServiceLab*** can synchronize the acquisition process. Several methods of synchronization have been implemented. These settings are defined in the Options dialog box.

The following settings are available:

One Sample per

- For the Data Point and Line Of Data modes, a ***ServiceLab*** block of size **1** is generated for each received data block. In the first case, this block is released for each channel individually. In the second case, all samples of the different channels are collected and released together, and the timing

information of all channels is the same, whereas in the first case each channel may have its independent time stamp.

- For the Global Sample mode, data is generated according to the global settings for block size and acquisition rate. The value received from the serial interface is used to generate the signal for ***ServiceLab*** for each channel. This mode allows to you synchronize slow serial inputs directly with faster inputs from data acquisition boards

Header Size

This option allows you to skip a defined amount of data at the beginning of each measurement.

It is better if the external device first sends an identification or ready string that without data after a Reset or start command.

11.3. Additional Data

You can define format strings for additional data to be sent to the Serial Interface. This data must be unambiguously recognizable**,** i.e., marked with special signs or strings. The data stream is always checked for these marks.

These options are available:

- Start time: Time information will be added to the real elapsed time and appended as new time information for each sample.
- Measurement time: Time information will be appended as time information with each sample.
- Sampling rate: Based on sampling rate, new time information is calculated and will be appended as time information.
- Block size: This option calculates the block size at the defined interface. Samples are released to the next ***ServiceLab*** modules once the defined number of samples is reached.

  To mark the values, the same characters are available as used in Data format. Brackets **[ ]** are necessary to identify the chosen value.

11.4. COM Port

This dialog box defines the parameters for the COM port used by ***ServiceLab***. The default settings are COM2, 9600 baud, 8 data bits, 2 stop bits and a buffer size of 4 K.

Hardware Settings

- Port: Specify the communications port to be used. Valid choices are COM1 to COM32.
- Baud rate: Define the speed of the communications device from 300 Baud to 57600 Baud.
- Data bits: Define the number of data bits (5 to 8).

- Stop bits: Define the number of stop bits (1, 1.5 or 2)
- Parity: Defines whether an additional parity bit per character is used. Choices are even, odd or no parity.
- Handshake: This entry defines whether data exchange is controlled by protocol and which type it is.

  None means there is no control. The hardware control lines DTR (Data Terminal Ready) and RTS (Request To Send) are disabled.

  RTS/CTS (Clear to Send) uses the corresponding control lines of the Serial Interface for hardware handshake.

  XON/XOFF uses control characters (17 and 19) to control the data stream. DTR and RTS hardware control is disabled.

  You can use one of the following options if there is an external device (i.e., interface converter) that needs a power supply using the control lines. In this mode, the RS232 interface will not use hardware control or software protocols to control the data stream.

  - Without (R0/D1), at initialization of interface control line DTR is active and RTS is passive.
  - Without (R1/D0), at initialization of interface control line DTR is passive and RTS is active.
  - Without (R1/D1), at initialization of interface control line DTR and RTS are active.

Buffer Settings

The Receive Buffer is the buffer used by Windows to buffer characters received by the serial port. Its size can be defined using this control. This buffer allows ***ServiceLab*** to receive data in the background even if a foreground task is active or the user is dealing with windows. The size may vary between 4 KB and 32 KB.

The Send Buffer for sending request strings is limited to 512 characters.

External Hardware Settings

Please refer to the hardware manual of your external device in order to choose the right settings for the serial port.

The defined parameters are displayed in the main dialog box as a string.

11.5. Monitor

This function allows you to easily communicate directly with the external device:

- You can send any string.
- All received data, including control characters, is displayed.

This simple tool allows you to configure the interface communication. Although you cannot read measured values directly into ***ServiceLab,*** you will see how

your data actually appears, and how ***ServiceLab*** will interpret it with the current module settings. You will be able to quickly determine the correct settings for the RS232 / ICom input module using this information.

Input window

You can define any string in the input window at the top of the monitor window. The string can include control characters:

For example, `\x1bai0\r` will produce the string: `<Esc>ai0<CR>` (Hex: 1b 61 69 30 0d).

Buttons

Send String: When you press the Send button, the contents of the input window are sent to the serial interface.

Save / Load String: Press the Save String No. 1 to No. 4 buttons to save the displayed string into an internal buffer. The buffer will be overwritten with the new string.

Press the Load String No. 1 to No. 4 buttons to restore one of the saved strings. Any existing text in the entry field is replaced by the stored string but is not sent to the serial interface. Only the buttons for used buffers are activated. Saved strings are stored with the worksheet if you close both dialog boxes with the OK button.

Send Data Request Command (Channel 0 -15): Use the Send Data Request Command buttons to send the stored requests (OptionsOPTIONRS232) to the serial device. The button is grayed out if the string does not exist. The sent string is not displayed.

Send Reset / Start / Stop: The Send Reset, Send Start and Send Stop buttons send the string(s) defined in the Options menu. The string sent is not displayed.

Output window

Received data is displayed in the lower window.

2 different display formats are available:

- ASCII**:** All characters are displayed in ASCII format. Characters with ASCII values > 31 (no control characters) are directly displayed as windows ANSI characters.

  Control characters (values ≤ 31) are displayed with the abbreviation of their control function (for example, <CR> for character 0d hex = 13 decimal or <ESC> for character 1b hex = 27 decimal).

  You can choose from 2 modes when displaying the characters as ASCII. In Automatic Word Wrap mode, each <CR>, <LF> or <CR><LF> causes a line break. This mode offers the clearest display type. If the selected mode is Off, all characters are written consecutively until the end off line is reached (ca. 48 - 56 characters). Then the next line will be used.

The Off mode is recommended if many characters have to be displayed.

- HEX: The second format is the hexadecimal display. Each character is displayed as a two-digit hex character. Additionally, the accompanying ASCII character is shown at the right.

  If the character is a control character (ASCII code smaller than 32) the ASCII character displayed is a dash. Each line always contains 16 hex values + the accompanying ASCII character.

Up to 30.000 characters of text are buffered internally. Each time if you reach the limit, the first text line is deleted. You can display all lines using the scroll bar. New characters are added to the end of the text. If necessary, an automatic line break generates a new line and scrolls the text up. If you switch the display mode (automatic formatting on/off), any existing characters are unchanged. New characters are handled according to the selected mode. The ASCII mode and the HEX mode have their own text buffer. Switching between ASCII and HEX mode doesn't change the contents of the buffers and the display of the different modes doesn't change. Enabling or disabling the Format String Debugging mode also does not change the text buffers. New characters are displayed according to the selected mode.

Check Parsing

Format String Debugging is a useful tool to assist you in detect errors in your Format Strings or to help in creating a Format String. A basic function of the Format String-Debugging is to mark Parser activities with colored characters. The parser divides the received series of characters into parts corresponding to the settings in the Format String:

- skipped characters (e.g. "6x" in the Format String) are displayed in black
- values (e.g. "a" for an ASCII value or "i" for an Integer in the Format String)
- search strings
- values, stored in global Variables
- channel arithmetic

Different colors are assigned to each of these elements. You can change the colors with the color setting dialog. If the corresponding element is recognized the concerning characters are colored.

If Check Parsing is active, the behavior of a running serial module is simulated without the need to start the worksheet. In this case, the channels and the format strings are processed in the same order as in a real experiment. The “Tracing Channel” area shows the last received value in the Output column. If the value is assigned to a global string, the value area shows the number of the string. For example:

$25=1.345

The global String 25 is assigned to a value of 17,345 in this example.

The "Ready to receive" column shows that channel waiting for the next value; therefore the format string the next data received will be interpreted. The channel is shown as follows:

> *Module skipping channel number (Module number/channel number in module)*

The module skipping channel number is the channel number that is shown above the modules channel bar if slave modules are used (counted from 0 to max. 255). The channel number in the module is the n^{th} channel in the module, counted from 0 to a maximum of 15.

Example:

> *45 (2/13)*

In the example the *Module skipping channel number* is 45, which corresponds to the 13th (start at 0) channel of the 2nd (start at 0) module. Move the mouse over the channel area and wait about 2 seconds to show a tip with detailed channel information.

Format-String Debugging (Examples)

Example 1:

The Format String is set to:

> *9x a\r*

The following characters are received via serial interface: (<CR> is assigned to a Byte with value 13 (Hex: 0x0D):

```
Voltage: 17.3 V<CR>
```

The Monitor shows the following:

```
Voltage: 17.3 V<CR>
```

The string "Voltage: " is skipped because the format command is "9x". The following characters are interpreted as value until the next <CR> is received. The parser recognizes "17.3 V" as string, to be converted into a value. Because the converter uses only numerical characters only the characters "17.3" are used and the "V" will be ignored. Although the parser recognizes the "17.3 V" as a value element. The meaning is shown in the next example.

Example 2:

The same format string is used as in example 1:

```
9x a\r
```

but some additional characters are received:

```
Current: 1.5 A; Voltage: 17.3 V<CR>
```

The Monitor shows the following:

Current: 1.5 A; Voltage: 17.3 V<CR>

Also in that case a voltage of 17.3 V should be recognized, but because to less characters are skipped the parser takes "1.5 A; Voltage: 17.3 V" as the string to convert. Because the next character after the “5“ is a space, the rest of string is ignored. The result is thus 1.5.

Example 3:

The format string is similar to the examples 1 and 2, but some more characters are skipped:

20x a\r

The same text as in example 2 is received:

Current: 1.5 A; Voltage: 17.3 V<CR>

The Monitor shows the following:

Current: 1.5 A; Voltage: 17.3 V<CR>

Again the voltage of 17.3 V should be recognized and the parser takes the color-marked characters: "age: 17.3 V". The converter ignores all characters until the first numerical character is detected! So in that case the correct value 17.3 is calculated!

Hint:

It is important to understand the two steps to calculate the values in a characters stream:

1. *Parsing:* getting the string (or Byte sequence) representing the value
2. *Converting:* calculates the numerical value out from the string (or Byte sequence) resulting from step 1.
3. Converting an ASCII strings (only valid with the format sign "a") is performed wit the following steps:
4. Search for the first numerical character (+ - e E.,0123456789) in the string.
5. Interpretation of the next part of string as a numerical value until the first non-numerical character.

The Buffer Display (not available with ICom module)

The Buffer display shows status of the internal buffer of the Serial Module. You can define the buffer size in the Interface Comm. Port settings of the Serial Module:

Example:

530/4096 (13%)

In the example the buffer contains 530 characters = 13%. A maximum of 4096 characters is available. The bar visually displays the percentage load of the buffer.

11.6. Additional Controls

- Save: This option stores the complete setup of the module in a separate file for later use. The file extension is SIN.
- Load: This option loads a previously saved setup. It reads files with the extension SIN.
- Send Reset: Click on this button to close and reopen the serial port and to send the defined reset command.

The default directory for the configuration files can be defined in the Options menu.

The Experiment: Serial Devices menu command allows you to link any serial device by name with the corresponding configuration files. The devices then are displayed in the list of predefined devices and can be inserted directly into the flowchart, without the need to reload a configuration file.

Please note the settings made after saving a configuration file are not stored automatically with the flowchart. To save these changing you must use the Save button in the module dialog box. Please pay attention to select the correct configuration file name linked to the selected device name.

11.7. RS232/ICOM Input Data Format

Define how ***ServiceLab*** interprets the values coming in at the serial interface in the Data format box of the RS232 Output module. These settings are valid for the selected channel. It is possible to define different strings for each channel.

The following format types are available:

Data Type	Number of Bytes	Format code	Range
ASCII Text	Optional	a	up to 16 characters
ASCII Hexadecimal	Optional	ah	up to 16 characters Integer only
Byte without sign	1	b	0 ... 255
Integer with sign	2	i	-32768 ... 32767
Unsigned Integer	2	w	0 ... 65535
Long Integer with sign	4	l	-2.14 e9 ... 2.14 e9

Data Type	Number of Bytes	Format code	Range
Long Unsigned Integer	4	u	0 ... 4.29 e9
IEEE Floating point	4	f	3.4 e+/- 38 (7 digits)
IEEE Double Floating point	8	d	1.7 e+/- 308 (15 digits)

Others	Format code	Restrictions
Read text string into Global String	$x x= String No.	Max 256 char.
Wait for a special String	"String"	Max 16 char.
Channel number	c	-
Arithmetic channel number	+ or -	+/- 999
Interpret as Hexadecimal	h	only ASCII
Skip character	x	max 3 times max 999 signs
Mask	Hexadecimal defined length	Binary only
Interpret as Hausmann-Code	ahh	ASCII Only
Interpret as 32 bit value	l	ASCII Only
End	free, use \x...	only if length is unknown

The format string must contain one of the format characters to identify the type of data. Different types have different preconditions:

- ASCII:

  This data type is always interpreted as an alphanumeric text string. If the external device sends data with fixed block length, you may place a numeric value directly before the format sign. This value defines the length of the received data string. If the value lengths are different, omit this value. The sample will be identified by leading and following spaces or non-ordinal numbers. The following characters are valid characters to mark measured values:

  0 ... **9 + - . , E e**

  All other characters mark the end of the measured value. For a fixed length value, the part with the defined length will be cut out and all marks except the previous characters will be deleted. After that the measurement value will be converted into ***ServiceLab*** format and transferred to the next module.

- ASCII hexadecimal:

  When a value is sent as a hexadecimal text string (one character uses 4 bit hexadecimal) it is marked by an **a** followed by **h**. The ASCII characters **0** ... **9**, **A** ... **F**, **a** ... **f** will be recognized. The measurement value will be interpreted using this character.

- Data type Motorola code:

  As default, all data with the formats **w** (Integer without sign), **i** (Integer with sign), **l** (Long Integer with sign) and **u** (Long Integer without sign) are interpreted as **Intel** format data, so the **lowest** byte (LSB) will be read **first** and the **highest** byte (MSB) **last**.

  If data is stored in **Motorola** format, with the **highest** Bit **first** (MSB) and the **lowest byte last** (LSB). To prevent incorrect interpretation of the data, you must add the **y character** to the data type code to force the program to recognize data as Motorola data (e.g. **ly** if Long Integer data with sign in Motorola format has to be interpreted).

- Other types of data:

  The length of the data string is based on the type. Defined bits (for example: information about status) could be blanked (except Float and Double). You must use a mask byte (hexadecimal with conform length) after format sign.

- Read Text String:

  The RS232 Input module can read ASCII text and assign it to a Global String. You can mix value channels and text string channels. When you define strings to be read, the RS232 Output module still shows an output, but no values are transmitted to it. The corresponding Global String will be defined by the settings in data format.

  The syntax is: $[string]

  [string] is the number of the Global String to be written. This variable is a number from 1 up to 100.

  Example: `5x $32\n`

  The first 5 characters are ignored. All following characters are read until a linefeed mark (Character 10) is recognized. The received text is assigned to Global String number 32.

  Hint: All characters with an ASCII value from 32 to 255 (32 = blank) are accepted. Smaller values are ignored. Maximum number of characters is 256.

- Skip Characters:

  To get the exact Start position of the measurement value in data string, it is possible to skip characters. Use the x parameter preceded by the number of characters to skip.

The following example of a format string shows you how to skip characters in string (n**X**):

2x	**6a**	**5x**	
--			both first characters are ignored
		--	the next 5 received bytes are deleted

This control code has to be separated by a Space from the other parts of the format string. The maximum number is 999.

You can use this parameter up to three times per format string.

- Waiting for a string:

  The following example of a format string shows you how to wait for a defined string within the data string:

"Abc\r123"	**2x a \r**
---------	Characters **Abc**, Control code **\r** (Return) and the numerical characters **123** have to be found in exactly this order. Then two characters are ignored and the next characters are interpreted as ASCII values. All preceding characters are lost.

  You may divide the control code from the rest of string with blanks, although it's not necessary. The blanks must be placed before the control code of the data format.

  Maximum length of the string is **16 characters**.

  This parameter can be used in each format string but only once per string.

- Channel in data string:

  An additional option is available which correctly arranges the samples received when several channels come in with irregular distances. First, the external device must send an identification signal. Use the c parameter to define this channel information. It is also necessary to define the data type after the c parameter. The same conditions as the measurement values are valid. Mixed data where the measurement value is a type other than the channel value will be recognized. If the length of the channel info is known, the length value has to be placed before the parameter c.

  The channel info requires a numerical value from 0 to 15. If the channel number doesn't agree with the definition, it can be computed using simple arithmetic. Insert a numerical value, starting with + or –, behind the format character. This value will be added to or subtracted from the calculated channel number. It is important that the arithmetic values of all channels are equal because it is not known which channel is sending at this time.

  When a channel is calculated that doesn't exist or isn't activated, the received value won't be transmitted.

The following example of a format string shows how to process additional channel information within the data string:

`1x` **`3ca-32`** `2x a \r`

`-----`

`c` marks the channel information; **`a`** marks the ASCII data. The leading **`3`** defines three characters to contain the information. When other types of data are used, you may not use numeric values. The string **`-32`** is used as an arithmetic value; 32 is subtracted from the determined numeric value of the channel. The new value defines the number of the channel in the module.

`1x` **`ci`** `1x i`

`--`

In this example, channel information is a 2 byte Integer (**`i`**). The value determined is used directly as the channel number.

The complete string of parameters must be separated by a blank from the other parts of the format string. It can be placed before or after the data format control code.

- Hexadecimal / Hausmann Code:

  The switch **`h`** forces ***ServiceLab*** to take the data as hexadecimal values. The format code **`ahh`** generates an input / output in **Hausmann code**.

  The Hausmann Code is an ASCII Hex format that reads the characters in reversed order.

  Example:

Decimal	Hex	Hausmann Code
50	32	2300
100	64	4600
1000	3E8	8E30
1550	60E	E060
2000	7D0	0D70

  With an appended **`l`** in the format string (e.g. `xxahl`) the value will be interpreted as 32 bit value. Without that character, all numbers in-between the interval Hex 8000 and Hex FFFF are interpreted as **negative** values.

- End:

  Basically, ***ServiceLab*** tries to recognize the start and end position of data strings using the length. Without a known length (ASCII without length information), we need an unambiguous code to recognize the end of the data string. This code may start with a Backslash \. Some special codes are predefined (see Data request). No predefined code will be defined by a preset x (hexadecimal). Only one code can be predefined.

11.8. RS232 Input Examples

11.8.1 Example 1: The external device sends data continuously without any request.

The following simple example shows the **continuous** data acquisition of **two** channels. Data values are sent by the external device **without request**:

Request strings:	both empty.
Format string 1st Channel:	**2x a \r**
Format string 2nd Channel:	**2x a \n**

In this example data acquisition is shown step by step. Characters from the earlier step are wiped out. (***ServiceLab*** works in the same way).

ServiceLab always starts on channel 1:

For example, the external device sends following characters (<CR> = Control code 0Dh, <LF> = Control code 0Ah, **¤** is used here to mark a Space):

A3¤**23.768**<CR>**A9**¤**345**<CR><LF>**A3**¤**23.950**<CR>**A9**¤**340**<CR><LF>...

--- both these characters are ignored (**2x** a \r).

¤23.768<CR>A9¤345<CR><LF>A3¤23.950<CR>A9¤340<CR><LF>...

------- these characters are interpreted as ASCII (23.768), (2x **a** \r).

<CR>A9¤345**<CR><LF>**A3¤23.950**<CR>**A9¤340**<CR><LF>**...

---- this character marks the end of the channel (2x a **\r** ➔ CR ➔ 0Dh ➔ 13).

The numerical value 23.768 is sent to the first output of the module.

Now the second channel is in process and the format string of the 2nd channel is used.

A9¤**345**<CR><LF>**A3**¤**23.950**<CR>**A9**¤**340**<CR><LF>...

-- both these characters are ignored, (**2x** a \n).

¤345<CR><LF>**A3**¤**23.950**<CR>**A9**¤**340**<CR><LF>...

---- these characters are interpreted as ASCII (345), (2x **a** \n).

<CR><LF>**A3**¤**23.950**<CR>**A9**¤**340**<CR><LF>...

---- this character is ignored (no ASCII character, no End mark).

<LF>A3¤**23.950**<CR>**A9**¤**340**<CR><LF>...

---- end of channel mark is recognized (2x a **\n** => LF => 0Ah => 10).

345 is sent to the second Output of the module.

Now the format string of the 1st channel is used again:

A3¤**23.950**<CR>**A9**¤**340**<CR><LF>...

-- both these characters are ignored (**2x** a \r).

¤23.950<CR>**A9**¤**340**<CR><LF>...

------- these characters are interpreted as ASCII (23.95), (2x **a** \r).

<CR>A9¤340<CR><LF>...
`----` end mark of channel is recognized (2x a **\r** => CR => 0Dh => 13)

23.95 is sent to the first Output channel.

Now the format string of the 2nd channel is used again:

A9¤340<CR><LF>...
`--` both these characters are ignored (**2x** a \n).

and so on...

11.8.2 Example 2: The external device sends all available values caused by one request.

The following simple example shows **continuous** data acquisition on **two** channels. Data values are sent by the external device **by request**:

Request string 1st channel :	**GET AI 1,2\r\n**
Format string 1st channel:	**3x 6a**
Request string 2nd channel:	read
Format string 2nd channel :	**1x a \n**
Sample Interval:	**1** Second

Data acquisition is shown step by step in this example. Characters of the earlier step are **wiped out**. (***ServiceLab*** works in the same way).

ServiceLab always starts on channel 1:

ServiceLab sends the request string **GET AI 1,2**<CR><LF> via serial port to the external device. **Send time** is stored.

The external device will answer by sending two samples:

K01123.45,234.56<CR><LF>
`---` these three characters are ignored (**3x** 6a).

123.45,234.56<CR><LF>
`------` these six characters (decimal as character) are interpreted as ASCII (3x **6a**).

123.45 is sent to the first output channel of the module.

The first channel and the first format string are now completely processed.

Now the Format string of the 2nd channel is used:

,234.56<CR><LF>
`-` this character is ignored (**1x** a \n).

234.56<CR><LF>
`------` these characters are interpreted as ASCII (1x **a** \n).

<CR><LF>
`----` this character is ignored (no ASCII, no End mark).

<LF>

---- channel end mark is recognized (1x a **\n** ➔ LF ➔ 0Ah ➔ 10).

234.65 is sent to the second Output channel of the module.

The second channel and the second format string are processed completely.

Now ***ServiceLab*** waits until the last send time added to the Sample Interval (in this case 1 sec) is reached. The request string: **`GET AI 1,2`**`<CR><LF>` is sent to the external device again, so the external device will send the next two samples and so on.

11.8.3 Example 3: The external device sends only one value on each request.

The following simple example shows the data acquisition with **two** channels. **Each request** causes the external device to send one data string:

Request string 1st channel: **`\x1bT01`**

Format string 1st channel: **`a 5x \x3b`**

Request string 2nd channel: **`\x1bT02`**

Format string 2nd channel: **`a 5x \x3b`**

Sample Interval: **5** seconds.

In this example data acquisition is shown step by step. Characters of the previous step are **wiped out**. (***ServiceLab*** works in the same way).

ServiceLab always starts on channel 1.

ServiceLab sends the request string `<Esc>`**`T01`** via serial port to the external device. **Send time** is stored (**`\x1b`** = hexadecimal 1b => 27decimal => Esc).

The external device will answer by sending one sample, for example:

`6543.2ABCDE;`

------ these characters are interpreted as ASCII (**`a`** `5x \x3b`).

`ABCDE;`

----- these 5 characters are sent by the external device but are unimportant so they are ignored (`a` **`5x`** `\x3b`).

`;`

- end mark of channel (Semicolon, Hexadecimal 3b) is recognized (`a 5x` **`\x3b`**).

6543.2 is sent to the first Output channel of the module.

The first channel is completed.

Now the request string of 2nd channel (`<Esc>`**`T02`**) is sent to the external device (**`\x1b`** = hexadecimal 1b => 27decimal => Esc).

The device answers by sending the next string, i.e., :

`1.234stuvw;`

----- these characters are interpreted as ASCII (**`a`** `5x \x3b`).

`stuvw;`
`-----` these 5 characters are sent by the external device but are unimportant. so they are ignored (a **`5x`** `\x3b`).

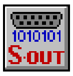
`;`
`-` channel end mark (Semicolon, Hexadecimal 3b) is recognized (a `5x` **`\x3b`**).

Value 6543.2 is sent to second output channel of the module.

Second channel is completed.

Now ***ServiceLab*** waits until the last **send time** plus the Sample Interval (in this case 1 sec) is reached. Then the request string `<Esc>`**`T01`** is sent to the external device again, so the external device will send the next two samples and so on.

12. RS232 Output Module



Use this module to send data devices connected to the PC's serial ports.

This module sends data to measurement equipment or strings to external devices via any serial interface of the PC recognized by Windows.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	same as global block size
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	number of available serial ports

In a worksheet, this module can take data from up to **16** different channels and transfer it to the RS232 Interface or it can send predetermined strings to the RS232 Interface initiated by status messages or Event Driven Actions.

Double-click on this module symbol in the worksheet to open the module configuration dialog box, where you can enter the number of channels available on your hardware using the channel bar.

ServiceLab keeps the COM port open while a worksheet with a RS232 module is loaded. When the experiment is started, the serial interface will be closed and re-opened to reset the port parameters and to use the actual parameter settings. Additionally, this clears the Windows serial buffer, so any data from a previous experiment is lost.

⇨ This approach has been chosen to enable the user to prepare worksheets on one computer that may have different serial port settings than the target computer that will run the application.

To check the settings without starting the measurement, use the Send Reset button. This causes the serial port to be closed and re-opened. The defined reset string is also sent.

12.1. RS232 and ICOM Modes

Send data

All incoming data samples are sent to the serial interface. The data format is defined in the Output (Format) window.

The Output of item continuous Data has to be selected. In this case, with control is grayed out and not available. You can enter the format characters and additional data in the Output (Format) field.

Send strings ruled by control signal

In this mode, the module uses one channel for control. Incoming values at the input of that channel will be interpreted as 0 (numerical value < 2.5) or 1 (numerical value > 2.5). The Output (Format) string will be sent to the RS232 interface when the edge of the control signal is rising (Transition 0 to 1).

Single command and with control input options must be activated.

Sending strings ruled by Event Driven Actions

In this mode, the module doesn't receive an input for the activated channel. Only the Output (Format) string is sent to the interface when an event driven action is performed. The single command option has to be activated and with control input must be deactivated.

12.2. Com Port

See page 3-27 in the RS232 Input module.

12.3. Additional Controls

- Save: This option stores the complete setup of the module in a separate file for later use. The file extension is SOU.
- Load: This option loads a previously saved setup. It reads files with the extension SOU
- Send string: Click on this button to send a string to control settings of interface and check the function of control strings.

The default directory for the configuration files can be defined in the Options menu.

12.4. RS232 and IEEE488 Output Data Format

The Output (Format) field of the RS232 Output module tells ***ServiceLab*** how and what data has to be sent. This entry only applies to the selected channel.

You are allowed to freely mix the following characters and bytes:

Data

If incoming ***ServiceLab*** data is sent to the RS232 interface, you have to use a format character. The format character has to be placed between brackets. The following types are possible:

Data Type	Number of Bytes	Format code
ASCII Text	Optional	a
Byte without sign	1	b
Signed Integer	2	i
Unsigned Integer	2	w
Signed Long Integer	4	l
Unsigned Long Integer	4	u
Floating point IEEE Float	4	f
Floating point IEEE Double	8	d

If the ASCII switch is active, the data is sent as a text string. Optionally, you can define the length using a numerical value after **a** [xx] (enclosed in brackets). It defines the overall length and, if necessary, the number of fractional digits. You don't need to define fractional digits if no fractional digits will be sent. If no length is defined, as many digits as needed are sent, including one digit for the sign and 3 fractional digits. The decimal divider, comma or decimal point counts as one digit. The default separator is the point. Positive values are preceded by a blank, negative values a “–”. If values are received which are outside the valid range, the smallest or largest possible value is sent. The number of characters to be sent will not increase. Leading zeros will be replaced by blanks.

It is also possible to send data using the ASCII hexadecimal format. Use the format code **a** followed by **h**. Data values will be converted to the hexadecimal value. 4 bits build one hex code. Fractional digits are not allowed in this mode.

Use the other format codes to send the data values will be send in the corresponding format. If values are received which are outside the valid range, the smallest or largest possible value is sent. The number of characters or bytes to be sent will not increase. Leading zeros will be replaced by blanks.

Control characters

A string may contain control characters which start with '\' (Backslash), followed by a hexadecimal code which is marked with '\x' (\x0d = Return), or an octal

value triggered by a '\0' (Backslash Null) (\0015 = Return), or a control character starting with '\' (Backslash).

The following control characters are available:

'r'	Return
't'	Tab (HT)
'a'	Signal (BEL)
'n'	Line Feed (LF)
'b'	Backspace (BS)
'f'	Formfeed (FF)
'v'	Vertical Tab (VT)

Checksum

The string to be sent may also contain one or more check bits. Use **\c** followed by the type to build the checksum. The position in the string also defines the position of the check bit. Two different checksum types are implemented:

- horizontal sum: \cq

  All bytes of the string before \cg are added (starting at the beginning of the string or after the last checksum sign, including data values). Carries are not considered. The resulting byte will be placed at the defined place in the data string.

- CRC-check: \cc

  All bytes of the string are calculated using the CRC algorithm (cyclic redundancy check). The resulting byte will be placed at the defined place in the data string.

12.5. Global Strings/Variables

In addition to sending pre-determined strings, you can also send the contents of global strings and global variables via RS232 Output module to the corresponding serial interface.

To use the global variables you have to use placeholders similar to the sending of regular data (e.g. [a] in square brackets: Output as ASCII or [i] output as Integer).

With global strings you must also use a placeholder, but format is not important. Simply use the placeholder [a].

Text and control codes before and behind the placeholder are also sent.

E.g. if you use the following string: **ABC123[a]\r\n**

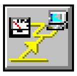
with the contents of the string: **XyZ**

you get the following output: **ABC123XyZ<CR><LF>.**

If only [a] is used, only the contents of the global string is sent.

Sending global Strings/Variables is only possible when using an event driven Action.

13. ICOM (TCP/IP) Input Module



Use this module ***to scan data coming from devices connected to the PC's serial,*** *or* ***TCP/IP ports****. The module filters the needed values of the arriving data strings based on the module settings and sends them to the module outputs.*

This module can read data from up to 16 different channels and transfer them to other modules using its signal channels.

It also can read ASCII strings and write them into a Global String. You can mix value channels and text string channels. Double-click on this module symbol in the worksheet to open the module configuration dialog box, where you can enter the number of input channels available on your hardware using the Channel Number Selection Bar. Each activated Analog Input channel increases the number of module outputs, so that each channel can send its data to another module through a separate line.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16, and, with Slave modules, up to 256
Output Block Size:	1 or global block size
Max. Number of Modules:	up to 8, if the serial ports are available

One ICOM Input module is able to acquire data in up to 16 channels from any serial, TPC/IP or NI GPIB interface of the PC that is recognized by Windows (up to 32 interfaces with the 32-bit version of ***ServiceLab***.) All blocks of data are provided with block size and timing information that is necessary to process data in ***ServiceLab***.

When inserting the ICOM Input module into the flowchart you can select whether a module is created as a default module (with the usual default settings for all parameters) or as a predefined module with parameters configured for a specific device. Predefined modules can be selected from the list box. They are created using the menu command Experiment:-> Serial Devices (see Book 1: User Guide: Chapter 4, Section 1.4.11 Serial Devices).

If there is already one ICOM Input module in the worksheet, you can add additional Slave modules to the Master module. Each Slave module expands the Master module by up to 16 channels. If you add a new ICOM Input module to the worksheet, you must define whether the module will be a new Master module (linked to another ICOM interface) or will be a Slave module of an existing Master module. If there are several Master modules you can choose between them. The Slave module settings are limited to Data Request, Data Format and Data Acknowledge parameters.

If a Master module is deleted, all assigned Slave modules lose connection. You can no longer use these modules in the worksheet.

The ICOM Input module filters data values from the arriving data strings based on the module settings and sends them to the module outputs. The resulting signal sent to ***ServiceLab*** consists of a number of blocks with different time intervals, with only one data point in each block, and with different starting times. As an alternative, the data can be stored in a separate buffer and can be sent to ***ServiceLab*** with the global acquisition rate and block size. This approach allows an easy synchronization of serial and other data.

ServiceLab holds the selected COM port open during the time a worksheet with a ICOM module is loaded. When the experiment is started, the serial interface will be closed and re-opened to reset the port parameters and to use the actual module settings. Additionally, this clears the Windows serial buffer, so any data from a previous experiment is lost.

This approach allows the user to prepare worksheets on one computer that may have different serial port settings than the target computer that runs the application.

To check the settings without starting the measurement, use the Send Reset button. This causes the serial port to be closed and re-opened. The defined reset string is also sent.

If the ICOM Input and Output modules use the same serial interface and the input module uses a data request string, receiving and sending are completely synchronized, so reading and writing of data via RS232 happens alternately.

13.1. Module Settings

The ICOM Input module is substantially the same as the RS232 Input module, with the exception of the Interface setup. Please see the previous sections for a description of the module properties.

Data Request Command

The strings defined in this box are necessary to initialize a data request to the connected external device. If there is no request necessary this area is grayed out (Options button, see page 3-26).

See page 3-24 to get additional information about the data format of the request string.

Data Format

The serial interface can only receive data in ASCII format. See page 3-33, RS232/ICOM Input Data Format for more information on the data format of the interface modules.

Data Acknowledge String

If a measurement value is received, the series of characters defined in this entry field will be sent to the serial device. This option is needed if the external device has to receive an acknowledgement of the receipt of output values.

Options

See page 3-26 for information about the Options dialog. It contains the configuration setup for an external device including reset (optional), start and stop commands, synchronization and time-out conditions.

Additional Data

See page 3-27 for information about the Additional Data you can define to be sent to the ICOM interface.

13.2. Interface Configuration

After selecting the interface Driver (COM, TCP/IP), you can define the parameters for the selected interface. The available communications interfaces are

- COM: RS232 (serial)
- TCP/IP

COM Hardware Settings (Serial Port)

The default settings are COM1, 9600 Baud, 8 Data bits and 1 Stop bit. The buffer size (4 Kbytes) cannot be changed.

If Input and Output modules use the same interface port, these settings are used by both.

- Port: Specify the communications port to be used. Valid choices are COM1 to COM32.
- Baud rate: Define the speed of the communications device from 300 Baud to 115200 Baud. If you lose data with high baud rates you should disable the Release CPU time if idle Option in the Options menu, Global Settings.
- Data bits**:** Define the number of data bits (5 to 8).
- Stop bits: Defines the number of stop bits (1, 1.5 or 2)
- Parity: Defines whether an additional parity bit per character is used. Choices are Even, Odd or None (no parity).
- Handshake**:** This entry defines whether data exchange is controlled by protocol and which type it is.
  - None means there is no hardware control of data flow or using of a software protocol. Control lines DTR (Data Terminal Ready) and RTS (Request to Send) are disabled.
  - RTS/CTS uses the control lines of the serial interface for hardware handshake.

- o Xon/Xoff uses the control characters (17 and 19) to control the data stream. The hardware control DTR and RTS are disabled.

13.2.1 TCP/IP Hardware Settings

- Host IP-Address: This number defines the communication partner via its unique IP-Address. You can use the numeric address (xxx.xxx.xxx.xxx) or its corresponding name such as the name of the PC, or its Web address.
- Transport Protocol: specify the port address where the communication happens. For example, **WWW** is port 80. This number is automatically added to the address defined in the edit field above separated by a colon (:). You can also enter this number directly into the edit field (xxx.xxx.xxx.xxx:80). If in the IP Address a port number is used, that is not included in the selection list the entry **other Port** is shown.

⇨ *Please note that the Port numbers are only one part of the address. The module offers only a generic TCP/IP client, but no higher level protocols such as e.g. FTP or HTTP are implemented.*

[Also at this time the module is not able to communicate with HTTP Servers, because the HTTP Server cuts the connection each time a transmission is completed. The ICom module expects to keep the connection.]

13.3. Monitor

Click on the Monitor button to communicate directly with the external device.

- You can send any string.
- All received data, including control characters, is displayed.

This simple tool allows you to configure the interface communication. Although you cannot read measured values directly into ***ServiceLab,*** you will see how your data actually appears, and how ***ServiceLab*** will interpret it with the current module settings. You will be able to quickly determine the correct settings for the RS232 / ICom input module using this information.

See page 3-28 for a full description and example of the Monitor function.

13.4. Additional Controls

- Save: This option stores the complete setup of the module in a separate file for later use. The file extension is IIM for ICOM Master Modules and .IIS for ICOM Slave Modules.
- Load: This option loads a previously saved setup. It reads files with the extension .IIM or IIS.

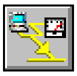
The Experiment: Serial Devices menu command allows you to link any serial device by name with the corresponding configuration files. The devices then are displayed in the list of predefined devices and can be inserted directly into the flowchart, without the need to reload a configuration file.

The default directory for the configuration files can be defined in the Options menu.

The Experiment: Serial Devices menu command allows you to link any serial device by name with the corresponding configuration files. The devices then are displayed in the list of predefined devices and can be inserted directly into the flowchart, without the need to reload a configuration file.

Please note the settings made after saving a configuration file are not stored automatically with the flowchart. To save these changing you must use the Save button in the module dialog box. Please pay attention to select the correct configuration file name linked to the selected device name.

14. ICOM Output Module



Use this module ***to send data to devices connected to the PC's serial, or TCP/IP port.***

Input and Output Characteristics

Number of Inputs:	Up to 16
Input Block Size:	Same as global block size
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	number of available serial ports

The ICOM Output module is able to send data to any (RS232, TCP/IP) interface of the PC that is recognized by Windows.

Inserting a serial module into the flowchart you can select, whether a module is created as default module (with the usual default settings in all parameters) or a predefined module with parameters configured for a special RS232 device is placed on the worksheet. Configured modules can be selected from the list box. They are created using the menu command Experiment-> Serial Devices

The COM (in RS232 mode) port is held open by ***ServiceLab*** *for the whole time a worksheet with a serial module is loaded. When the experiment is started, the serial interface will be closed and reopened in order to reset the port parameters and to use the actual parameter settings. In addition, this flushes the serial buffer provided by Windows, so that data from a previous experiment is deleted*

This approach has been chosen to enable the user to prepare worksheets on one computer that has different serial port settings than the target computer that will run the application.

If you want to check the settings without starting the measurement you can use the Send Reset button. This causes the serial port to be closed and opened again. In addition, the defined reset string is sent.

Each channel of this module is able to operate in one of three modes:

- Send Data
- Send strings controlled by control signal
- Send strings or global strings/variables controlled by event driven actions

See Section 12.1 RS232 Output Module RS232 and ICOM Modes on page 3-42 for more details.

Interface

See Section 0 Data Request Command

The strings defined in this box are necessary to initialize a data request to the connected external device. If there is no request necessary this area is grayed out (Options button, see page 3-26).

See page 3-24 to get additional information about the data format of the request string.

Data Format

The serial interface can only receive data in ASCII format. See page 3-33, RS232/ICOM Input Data Format for more information on the data format of the interface modules.

Data Acknowledge String

If a measurement value is received, the series of characters defined in this entry field will be sent to the serial device. This option is needed if the external device has to receive an acknowledgement of the receipt of output values.

Options

See page 3-26 for information about the Options dialog. It contains the configuration setup for an external device including reset (optional), start and stop commands, synchronization and time-out conditions.

Additional Data

See page 3-27 for information about the Additional Data you can define to be sent to the ICOM interface.

Interface Configuration on page 3-46 for details.

Additional Controls

- Save: This option stores the complete setup of the module in a separate file for later use. The file extension is SOU.
- Load: This option loads a previously saved setup. It reads files with the extension SOU

- Send string: Click on this button to send a string to control settings of interface and check the function of control strings. While mode continuous is chosen value is set to 0.0 (zero) and sent as data.

The Default Path for configuration files (.IOU) can be defined in the Options Menu.*

The ***Experiment: Serial Devices*** *menu command links a serial device by name with the corresponding configuration file. The devices are then are displayed in the list of predefined devices and can be inserted directly into the flowchart without reloading a configuration file.*

Please note that the settings made after saving a configuration file are not automatically stored with the flowchart. To save these changes you must use the Save button in the module dialog box. Please pay attention that you select the correct configuration file name linked to the selected device name.

15. IEEE488 Input and Output Modules (optional)

ServiceLab optional supports boards from several vendors. During the installation procedure you can choose between the different boards.

The following hints are valid for **all** board types. For specific help, click on one of the card types.

- INES
- IOtech
- National Instruments

The IEEE Output Module is not available for INES boards.

The default directory for the configuration file of the IEEE device can be defined in the Options menu.

General Hints

Communication Errors

If a communication error occurs, ***ServiceLab*** displays a message and stops the experiment.

Data Acquisition with more than one Device

If data is to be acquired from or sent to several IEEE devices, a separate IEEE Input module must be placed into the worksheet for each device. Each device must have a **unique** IEEE address.

You can specify a default directory for the ***configuration file*** *(`*.GPO`) of the IEEE device (Options menu command).*

See the following sections for more information.

- IEEE488 Input
    - INES IEEE488 Input
    - IOtech IEEE488 Input
    - National InstrumentsIEEE488 Input
    - IEEE Input data format
- IEEE488 Output
    - National Instruments IEEE488 Output
    - IOtech IEEE488 Output
    - IEEE Output data format
- IEEE Interface Options
- IEEE Interface Hardware settings
- IOtech Commands
- National Instruments Commands

15.1. IEEE488 Input Module (optional)

Use this module to acquire data coming into the PC via an IEEE interface.

15.1.1 General Hints

In a worksheet, this module can read data of up to **16** different channels and transfer them to other modules using its signal channels.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	1
Max. Number of Modules:	up to 15

Communication Errors

If a communication error occurs, ***ServiceLab*** displays a message and stops the experiment.

Data Acquisition with more than one Device

If data is to be acquired from several IEEE devices, a separate IEEE Input module must be placed into the worksheet for each device. Each device must have a **unique** IEEE address.

You can specify a default directory for the configuration file `(*.GPI)` of the IEEE device (Options menu command).

15.1.2 IEEE488 Input: INES Module

This module is used for the measurement acquisition of units with IEEE488 interface (IEC bus).

Prerequisites for this function are:

- an IEEE488 interface card from the INES company installed in your computer,
- the correct Windows drivers (*.DLL in the WINDOWS\SYSTEM directory; see the INES manual),
- and the ***ServiceLab*** INES driver (which must be selected during ***ServiceLab*** installation).

Most of the commands used to communicate with the IEEE card need a Device handle (a synonym for the address specified in Hardware Options) to talk to the device. Default handles are user for the measurement instrument and IEEE for the card. One of these handles is specified as command parameter (in parenthesis) defining the target of the command.

General Module Configuration

- Start Commands: Enter the commands necessary for the initialization of the IEEE board and the connected devices. They will be executed once when the measurement is started. For example:

`ABORTIO 7`	stop previous communication processes
`CLEAR 709`	reset interface
`SET 709,1000,9013,9013`	set terminators and delays
`OUTPUT 709,'xyz'`	initialize devices

- Stop Commands: These commands will be executed once when the measurement is stopped.
- Sampling Rate: The acquisition rate is taken from the Windows system clock. The maximum rate is 10 Hz or 0.1 seconds delay. If the connected device does not send data at the desired rate, no warning or error message will occur, but the next value will be accepted after the next delay. Every sample is provided with the current system time. The bus delays for the IEEE board must be adjusted using the INIT command in accordance with the acquisition rate.

- Data Format: Please see page 3-57 for more information on the data format of the different interface modules.
- Data Request: This command will be sent out whenever a value is requested by a device. The last line always must be `ENTER 7xx, %5`, which is necessary for the communication between ***ServiceLab*** and the IEEE board. For example:

`OUTPUT 709, ´xxyyzz´`	device-dependent request command
`ENTER 709, %5`	read value

A delay command `WAIT` *n* may be entered in these input fields, where *n* denotes the delay time in milliseconds. Any value may be entered, but these values are always rounded to multiples of 55 ms according to the cycle time of the system clock.

If a communication error occurs during measurement, an error message will be displayed, and the acquisition of data will be stopped.

To acquire from several devices, one IEEE module must be inserted into the worksheet for each device. The maximum number of external IEEE devices is 15, with each of them requiring a different device address.

You can specify the default directory for the configuration file of the IEEE device in the Options menu.

15.1.3 IEEE488 Input: IOtech Module

This module is used for the measurement acquisition of units with IEEE488 interface (IEC bus).

Prerequisites for this function are:

- an IEEE488 interface card from IOtech installed in your computer,
- the correct Windows drivers (∗.DLL in the WINDOWS\SYSTEM directory; see the IOtech manual),
- and the ***ServiceLab*** IOtech driver (which must be selected during ***ServiceLab*** installation).

The commands used with this module must conform to the syntax definitions of the IOtech card. For details concerning the syntax, please refer to the IOtech manual.

Most of the commands used to communicate with the IEEE card need a Device handle (a synonym for the address specified in Hardware Options) to talk to the device. Default handles are user for the measurement instrument and IEEE for the card. One of these handles is specified as command parameter (in parenthesis) defining the target of the command.

General Module Configuration

- Start Commands: Enter the commands to initialize the IEEE card and the measurement acquisition device. The commands entered here are out-

put/executed once at Measurement Start. A maximum of 50 command lines can be entered.

- The Start commands also can be executed using an asynchronous action. Use the Send Start Command action in the Action module.
- Stop Commands: The commands entered here are executed once at Measurement stop. This sequence can be used, for example, to deactivate the remote control (data acquisition via a computer) of a connected device. A maximum of 50 command lines can be entered.
- Data Format: Please see page 3-57 for more information on the data format of the different interface modules.
- Data Request: The commands specified here are executed one time for each channel before data acquisition takes place. Use this sequence to trigger the data acquisition and transfer of data.
- If data request is not cyclic but starts at a special event, use the Send Request asynchronous action. Use the Send On Action setting in the IEEE488 Options dialogue box.

Additional switches

- Click on the Hardware button to open the dialog box. Use this window to enter the various settings for the actual measurement device.
- The Options button allows other settings to be entered for the Acquisition rate and the Transfer mode.

⇨ *If a communication error occurs during communication with a device or with an IEEE card, a fault message will be shown in a separate window. The entire measurement will be stopped.*

⇨ *You must insert an individual IEEE module into the worksheet for each device to acquire data from several devices. Prerequisite for this is that all devices are operated via one IEEE card and set to different device addresses. A maximum of 15 devices can be connected to one IEEE card.*

☝ *You can specify the Default directory for the configuration file of the IEEE interface in the Options menu.*

15.1.4 IEEE488 Input: National Instruments

This module is used for the measurement acquisition of units with IEEE488 interface (IEC bus).

Prerequisites for this function are:

- an IEEE488 interface card from the National Instruments company installed in your computer,
- the correct Windows drivers (∗.DLL in the WINDOWS\SYSTEM directory; see the National Instruments manual),

- and the ***ServiceLab*** NI driver (which must be selected during ***ServiceLab*** installation).

The commands used with this module must conform to the syntax definitions of the NI card. For details concerning the syntax, please refer to the National Instruments manual.

Most of the Commands used to communicate with the IEEE card need a Device handle (synonym for the address specified at Measurement card parameter) to talk to the device. Default handles are user for the measurement instrument and IEEE for the card. One of these handles is specified as command parameter (in parenthesis) defining the target of the command.

Functions in the setting window

- Start commands: This entry field is used to specify commands to initialize the IEEE card and the measurement acquisition device. The commands entered here are output/executed once at Measurement start. A maximum of 50 command lines can be entered.
- Stop commands: The commands entered here are executed once at Measurement stop. This sequence can be used for example to deactivate the remote control (data acquisition via a computer) of a connected device. A maximum of 50 command lines can be entered.
- Data format: Please see page 3-57 for more information on the data format of the different interface modules.
- Data request: The commands specified here are executed one time for each channel before data acquisition takes place. Use this sequence to trigger the data acquisition and transfer of data.

Additional switches

- By clicking onto the Hardware button a separate settings window is opened. In this window to enter the various settings for the actual measurement device.
- The Options button allows other settings to be entered for the Acquisition rate and the Transfer mode.

If a communication fault occurs during communication with a device or with an IEEE card, a fault message will be shown in a separate window. The entire measurement will be stopped.

You must insert an individual IEEE module for each device into the worksheet to acquire data from several devices. Prerequisite for this is that all devices are operated via one IEEE card and set to different device addresses. A maximum of 15 devices can be connected to one IEEE card.

You can specify the Default directory for the configuration file of the IEEE interface in the Options menu.

15.1.5 Data format for IEEE488 Input

ServiceLab uses the Data format input field of the interface modules to determine how the value supplied by the measurement instrument should be interpreted. The settings always refer to the currently selected channel of the module. It is possible to define different strings for each channel.

The following format types are available:

Data type	Number of Bytes	Format designator
ASCII text	optional	`a`
Integer with sign	2	`i`
Integer without sign	2	`w`
Long Integer with sign	4	`l`
Long Integer without sign	4	`u`
Floating point IEEE Float	4	`f`
Floating point IEEE Double	8	`d`

If the ASCII switch is active, the string is interpreted as text. If binary is chosen, the string must contain one of the above format codes to identify the data type.

Parameter **nx** masks n characters in the string.

- Defined bits (for example: status information) can be blanked (except Float and Double). You must use a mask byte (hexadecimal with conform length) behind the format sign.
- Other data types:

  The type identifies the length of the data string. Defined bits (for example: information about status) can be blanked (except Float and Double). You must use a mask byte (hexadecimal with conform length) behind the format byte.

There must be spaces between each parameter of the format string.

Examples of format strings:

`2x a 5x \r`

Incoming values are interpreted as ASCII. The first two and last 5 received bytes are chopped. CR (0Dh) will be recognized as the end code.

`u`

Incoming value is interpreted as Long Integer. No bytes will be eliminated. Length is fixed to 4 bytes.

`i fff0 2x`

Value will be interpreted as Integer. The following two bytes are skipped. Only the first 12 Bits are masked out and are interpreted as numerical Integer value.

15.2. IEEE488 Output Module

Use this module to send data to an** IEEE488 **device.

In a worksheet, this module can send data on up to **16** different channels to an external IEEE device.

Input and Output Characteristics

Number of Inputs:	16 (depending on hardware and working mode)
Input Block Size:	same as global block size
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	up to 15

Working modes:

Each channel of this module is able to operate in one of three modes:

- Send Data
- Send strings ruled by control signal
- Send strings ruled by event driven actions

*You can specify a default directory for the **configuration file** (`*.GPO`) of the IEEE device (Options menu command).*

15.2.1 General Module Configuration

Start commands: This entry field is used to specify commands for the initialization of the IEEE board and the connected acquisition devices. The commands entered here are executed once when the measurement is started. A maximum of 50 command lines can be entered.

The Start commands also can be executed using an asynchronous action. Use the action Send Start command in the Action module.

Stop commands: The commands entered here are executed when the measurement is stopped. This sequence can be used, for example, to deactivate the remote control (data acquisition via a computer) of a connected device. A maximum of 50 command lines can be entered.

Output Data: The commands inserted in that field are executed each time before a sample of a channel is acquired. So you can initialize sending and define kind data to be transferred to the external device.

15.2.2 Working modes:

Each channel of this module is able to operate in one of three modes:

Send Data

- Send strings ruled by control signal
- Send strings ruled by event driven actions

⇨ *In this mode only the block size 1 is supported. If other sizes are used, only the first value of the block will be transferred.*

15.2.3 Additional Switches

Click on the Hardware button to open the dialog box. Use this window to enter the various settings for the actual measurement device.

15.2.4 Notes

If a communication error occurs during communication with a device or with an IEEE card, an error message will be shown in a separate window, and the entire measurement will be stopped.

To acquire data from several devices you must insert an individual IEEE Output module into the worksheet for each device. The prerequisite for this is that all devices are operated via one IEEE board and set to different device addresses. A maximum of **15** devices can be connected to one IEEE board.

15.2.5 IEEE488 Output: IOtech

This module is used for the measurement acquisition of with IEEE488 interface (IEC bus).

Prerequisites for this function are:

- an IEEE488 interface card from the IOtech company installed in your computer,
- the correct Windows drivers (*****.DLL in the WINDOWS\SYSTEM directory; see the IOtech manual)
- and the ***ServiceLab*** IOtech driver (which must be selected during ***ServiceLab*** installation).

To use the IOtech IEEE card you must provide the hardware handles for the interface and the device to ***ServiceLab***.

If needed, you can adapt the settings of the IEEE0 hardware handles used for the interface and Wave used for the device in the Hardware dialog box.

In ***ServiceLab,*** the interface handle is defined as IEEE (instead of IEEE0) and the device handle is defined as user (instead of Wave). One of these handles is specified in brackets after the command parameter and defines the target of the command.

The commands used with this module must conform to the syntax definitions of the IOtech card. For details concerning the syntax, please refer to the IOtech manual.

15.2.6 IEEE488 Output: National Instruments Module

This module is used for the measurement acquisition of with IEEE488 interface (IEC bus).

Prerequisites for this function are:

- an IEEE488 interface card from the National Instruments company installed in your computer,
- the correct Windows drivers (*.DLL in the WINDOWS\SYSTEM directory; see the National Instruments manual)
- and the ***ServiceLab*** NI driver (which must be selected during ***ServiceLab*** installation).

The commands used with this module must conform to the syntax definitions of the NI card. For details concerning the syntax, please refer to the National Instruments manual.

Most of the commands used to communicate with the IEEE card need a device handle (synonym for the address specified at Hardware Setup) to talk to the device. Default handles are user for the measurement instrument and IEEE for the card. One of these handles is specified as command parameter (in parenthesis) defining the target of the command.

15.2.7 IEEE488 Output Module Data Format

See page 3-43 for more information on the data format.

15.3. IEEE488 Hardware Settings

In this dialog box for the IOtech or National Instruments IEEE488 interfaces, various settings can be made for the actual measurement:

- The Device address specifies the IEEE bus address set at the measurement instrument.
- The Secondary address is used to specify the second address of the measurement instrument.
- The Timeout parameter specifies the time in milliseconds ***ServiceLab*** waits for this data from the measurement instrument. If this time is exceeded, ***ServiceLab*** aborts the measurement. Look for the relevant time value in software reference manual of the interface (for National Instruments the `IBTMO` command; for IOtech the `TimeOut` command). If this time is exceeded, ***ServiceLab*** stops the measurement.

15.4. IEEE488 Options

Click on the Options button to define the settings for the Acquisition Rate, the Transfer Type and the Scan Mode for IOtech or National Instruments IEEE488 interfaces.

All these settings relate to the interpretation of the data received by ***ServiceLab*** but not to the programming of the connected measurement instrument.

- Storage settings

  The settings made here are relevant if the connected IEEE-measurement instrument acquires the data independently and sends them to ***ServiceLab.***

  Storage rate: the desired acquisition rate for the device can be set in seconds.

  Storage mode:

  - Single values: one measurement value is requested for every active channel. Set the Transfer block length and the Output block length to **1**.
  - Block mode:

    AAA: One measurement block is requested for every active channel. The value set for Transfer block length specifies the block length.

    AAABBBCCC: All measurement values are stored block-by-block in channel **0**. The data of all other channels of the measurement instrument are available at channel **0** of the IEEE-module. The Transfer block length represents the number of values of a channel. With a Transfer block length of **n** the data is present **n** times in channel **0**, **n** times in channel **1**, ...etc. in the output data block.

    ABCABCABC:All measurement values are only requested with the command for channel **0**, read in by a read operation and assigned to the activated output channels. The number of output channels are specified with Transfer settings

- Transfer settings

  The settings made here are in direct relationship with the Storage mode selected in Storage settings. The Transfer block length per channel specifies the block length the IEEE device uses to transfer data.

  The Transfer buffer specifies the size ***ServiceLab*** reserves for receiving the data block. The buffer size must be sufficiently large to allow for the storage of an entire data block. If the size is below the required amount, the remaining data is read in with the next measurement value read-in command and thus falsely interpreted.

- Module settings

  These settings refer to the ***ServiceLab*** module itself.

  If Dispatcher mode is active, the measurement request commands are sent in intervals specified by the Acquisition rate. The incoming data is then processed. The highest acquisition rate is 0.1 seconds.

  The Output block length specifies the block length ***ServiceLab*** uses to transmit the data to other modules. The value specified must be the same or smaller than the Transfer block length set for the IEEE device.

- Data value acquisition

The operating module of the module is set here.

When the Dispatcher is selected and the measurement is started, ***ServiceLab*** automatically sends the measurement value request command in the time intervals set for the Acquisition rate.

When the Status request mode is active the IEEE device is responsible for the time base (Acquisition rate). In this mode the status of the device must be determined with the measurement request command (SPOLL command).

Example:

```
IF (spoll (user) & 16 == 1)
ENTER (user)
```

The data is read in if it is ready for transfer.

15.5. Command overview - IOtech IEEE card

The following commands are supported **for this card**:

`ABORT`	Output of an Interface Clear message
`CLEAR`	Reset of one or all devices
`ENTER`	Reading in of data of one device
`LISTEN`	Interface in Listener mode, data can be read from the bus
`LOCAL`	Sending of a 'Go To Local' message to all devices
`OUTPUT`	Sending of data to one device
`REMOTE`	Setting of the 'Remote Enable' line
`SPOLL`	Serial Poll scanning
`TALK`	Interface is in Talker mode, data can be outputted onto the bus
`TRIGGER`	Output of a trigger to one device
`UNLISTEN`	Reset the Listener mode
`UNTALK`	Reset the Talker mode

The following commands are interface card **independent**:

`IF`	Conditional execution, at this time only possible with `SPOLL`.
`ELSE`	The following condition is executed if the IF condition is not satisfied.
`WHILE`	Loop until the status is satisfied, otherwise the same as `IF` but without `BEGIN…END`.
`BEGIN…END`	All commands enclosed by these statements are conditionally executed.
`WAIT`	Following this command the waiting time can be specified in milliseconds. Execution of commands is

delayed by the specified time.

Examples:

Command sequences	**Explanation**

`IF (spoll (user) & 16 == 0)`
`BEGIN`
…
`END`
`ELSE`
`BEGIN`
…
`END`
	The `IF` command must be followed by a SPOLL command (operator &, comparison with ==, > , < , >= , <= possible).
	
	You cannot nest IF statements.

`WHILE (SPOLL (user) & 16)` `… instruction`	The WHILE loop is executed until the condition is satisfied.

15.6. Command overview - National Instruments IEEE card

The following commands are supported **for this card**:

`IBCLR`	Output of an Interface Clear message
`IBCMD`	Sending of interface commands
`IBCONFIG`	Changing of the interface parameters
`IBDMA`	Setting or resetting of the DMA mode
`IBEOS`	Changing or resetting of the End-of-String transfer mode
`IBEOT`	Setting or resetting of the End-of-Transition transfer mode
`IBLOC`	Switching of the device to Local mode
`IBPAD`	Changing the primary address
`IBRD`	Reading in of data into string
`IBRPP`	Parallel Poll scan
`IBRSC`	Setting or resetting of the interface features to output the Interface Clear and Remote Enable message
`IBRSP`	Serial Poll
`IBSAD`	Changing the secondary address
`IBSIC`	Sending of the Interface Clear message for 100µs
`IBSRE`	Setting or resetting of the Remote Enable line
`IBSTOP`	Terminating of the asynchronous operation
`IBTMO`	Changing of the Time Out value
`IBTRG`	Triggering of a device
`IBWRT`	Sending of a string to a device

The following commands are interface card independent:

`IF`	Conditional execution, at this time only possible with `IBRSP`.
`ELSE`	The following condition is executed if the IF condition is not satisfied.
`WHILE`	Loop until the status is satisfied, otherwise the same as `IF` but without `BEGIN…END`.
`BEGIN…END`	All commands enclosed by these statements are conditionally executed.
`WAIT`	The wait time can be specified in milliseconds following this command. Execution of commands is delayed by the specified time.

Examples:

Command sequences	Explanation

`IF (ibrsp (user) & 16 == 0)`
`BEGIN`
`…`
`END`
`ELSE`
`BEGIN`
`…`
`END`
	The IF command must be followed by a IBRSP command (operator &, comparison with == , > , < , >= , <= possible).
	
	You cannot nest IF statements.

`WHILE (ibrsp (user) & 16)` `… command`	The WHILE loop is executed until the condition is satisfied.

16. IVI Scope (optional)

*The module controls a **Scope device via the IVI interface**. The module only offers the basic function as described the IVI Class Specifications.*

Additional software to enable the module’s functions is required: You must install the IVI engine software shipped by the hardware manufacturer.

Input and Output Characteristics

Number of Inputs: ---
Input Block Size: ---
Number of Outputs: 1
Output Block Size: as defined in module
Max. Number of Modules: any

IVI Scope Specifications

The IVIScope specification defines the IVI class for oscilloscopes. The IVIScope class, defined by the IVI foundation (http://www.ivifoundation.org/) is divided into a base capability group (available in ***ServiceLab***) and extensions. The base capability group is used to configure an oscilloscope for typical waveform acquisition (including setting the channel, the acquisition, and the triggering subsystems), initiating the waveform acquisition, and returning a waveform. The base capability group supports only edge triggering and normal waveform acquisition.

In addition to the base capabilities, the IVIScope class defines extended capabilities for oscilloscopes that can:

- Have advanced triggering options such as TV, runt, glitch, width, and AC line
- Use alternative acquisition modes such as average, envelope, and peak detect
- Use different sample modes such as real-time and equivalent
- Perform waveform measurements such as rise-time, fall-time, and voltage peak-to-peak
- Sense the probe attenuation
- Perform an auto-setup
- Interpolate the points in the waveform record
- Acquire data continuously

General

When creating the module you must select the logical name of the oscilloscope device. ***ServiceLab*** checks all IVI devices installed in the system and shows them in the pull down list.

Parameter

Horizontal Offset: Time to wait (in seconds) since measurement starts, before data recording has to start.

Horizontal Range: Shown (or sampled) range in seconds.

Block Size: Number of samples to be recorded in the „horizontal range". These samples also build the block at the modules output.

Vertical Range: Define the maximum y value to be displayed.

Vertical Offset: Define the vertical shift of the displayed X-axis.

Trigger Source: This source is used to initiate trigger events.

- none: no trigger event will be expected. Trigger level and edge are not valid in that case.
- external: the scope is triggered by an external source.

Trigger Level: If the defined level is crossed a trigger event is generated.

Edge: defines the direction of level crossing

- rising: level has to be exceeded.
- falling: level has to be underrun.

Coupling: Define the kind of data source linked to the scope hardware.

- AC: Alternating current voltage
- DC: Direct current voltage

17. IVI Function Generator (optional)

*The module controls a **Function Generator device via the IVI interface**. The module only offers the basic function as described the IVI Class Specifications.*

Additional software to enable the module's functions is required: You must install the IVI engine software shipped by the hardware manufacturer.

Input and Output Characteristics

Number of Inputs:	1
Input Block Size:	---
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	---

IVI Function Generator Specifications

The IVIFgen class defined by the IVI foundation conceptualizes a function generator as an instrument capable of generating an analog voltage waveform, and can be applied to a wide range of instruments. The output signal is typically functional in nature (for instance sinusoidal or square). Some instruments support the generation of arbitrary waveforms, which consist of user-specified data. If the function generator also supports the generation of arbitrary waveform sequences, the output signal can consist of a sequence of repeated arbitrary waveforms. (http://www.ivifoundation.org/)

General

The IVIFgen class also supports more advanced features such as burst mode, AM modulation, and FM modulation. When creating the module you must select the logical name of the function generator device.

ServiceLab checks all IVI devices installed in the system and shows them in the pull down list.

Parameters

Clock Source: you can select an internal or external clock source.

Generator: you must select the logical name of the used function generator hardware.

The following parameters can be defined directly using the module dialog box or alternately via the module's inputs. When using the inputs, the module provides additional control inputs for each selected parameter.

Frequency: (F) The signal is generated with the defined frequency.

Amplitude:(A) The amplitude of signals reaches that value.

Offset: (O) To amplitude that offset is added.

Phase: (P) The phase of signal is shifted by that value (RAD)

Impedance: (I) You must define the impedance of the used device. Reasonable values are almost often **50** or **75** Ohms. If the defined value is not supported by the device an error message will be shown..

Duty Cycle: (D) This setting is available only if the **Rectangle** waveform is selected. The duty cycle is defined as ratio of length of pulse and length of period.

Wave Form: (W) Define a waveform the hardware has to generate. You can select between:

Sine	Value at the control input **W**: **0**
Rectangle	Value at the control input **W**: **1**
Triangle	Value at the control input **W**: **2**
Ramp rising	Value at the control input **W**: **3**
Ramp falling	Value at the control input **W**: **4**
Constant Level	Value at the control input **W**: **5**

To select a waveform via control input use the corresponding values.

18. IVI Digital Multimeter (DMM) (optional)

*This module is used to **acquire data** of a triggered time interval **from an IVI compatible DMM device** via the IVI interface driver The module only offers the basic function as described the IVI Class Specifications.*

Additional software to enable the module's functions is required: You must install the IVI engine software shipped by the hardware manufacturer.

This module imports signals from the Multimeter hardware device.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	**1**

Output Block Size: as defined in module
Max. Number of Modules: any

IVI DMM Specifications

The **IVIDMM** class, defined by the IVI foundation defines the functions the IVI digital multimeters class has to offer. It is divided into a group of basic functions (available in ***ServiceLab***) and expansions. The base functions are used to configure the multimeter to acquire common values (including selection of range, setup of resolution and selection of trigger source), to start acquisition and to display the measured value. The basic functions only support edge triggering and simple data acquisition (http://www.ivifoundation.org/).

In addition to these basic functions some IVI compatible DMM offer extended functions such as setup of the Max and Min input frequencies.

General:

When creating the module you must select the logical name of the digital multimeter device. ***ServiceLab*** checks all IVI devices installed in the system and shows them in the pull down list.

Basic Settings

Function:

Voltage:	AC, DC, AC+DC
Current:	AC, DC, AC+DC
Resistant:	2 wire, 4 wire
Frequency	
Period	

Auto range: This option tells the device to select the measurement range automatically.

Range: If you don't use the Auto Range function, you must declare a range.

Resolution: Number of digits used in the virtual display of the connected device.

This setting ha *no effect* ***on the display of the*** *Digital Meter* ***module in ServiceLab.***

Trigger Delay: The time delay after the trigger event to start the measurement.

Timeout:

Checkbox selected: Time after which the single measurement has to be finished. After that time an error message is displayed.

Checkbox not selected: Uses a very short time for time out ("instant" Setting)

AC Setting

Specifies the maximum/minimum frequency component of the input signal for AC measurements. The value of this attribute affects instrument behavior only when

the IVIDMM_ATTR_FUNCTION attribute is set to an AC voltage or AC current measurement.

Frequency Setting

Specifies the expected maximum value of the input signal for frequency and period measurements. Positive values represent the manual range. Negative values represent the Auto Range mode.

The value of this attribute affects instrument behavior only when the IVIDMM_ATTR_FUNCTION attribute is set to a frequency or period measurement.

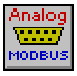
The units are specified in Volts RMS.

Measurement Options:

Sample Rate: You can define a module specific sample rate for the DMM hardware that is not affected by the ***ServiceLab*** time bases.

Block size: You can define a module specific block size for the DMM hardware that is not affected by the ***ServiceLab*** global block size.

19. MODBUS Analog Input and Output Modules (optional)



*Use this module to **acquire data from industry-standard MODBUS devices**.*

What is Modbus?

MODBUS® Protocol is a messaging structure developed by Modicon in 1979, used to establish master-slave/client-server communication between intelligent devices. It is a de facto standard, truly open and the most widely used network protocol in the industrial manufacturing environment... For more information about Modbus please see http://www.modbus.org or check either the Modbus Library or the FAQs

Supported MODBUS Functions

MODBUS Analog Functions 0x1, 0x3, 0x4, and Digital Functions 0x10, and 0xF are supported.

MODBUS Analog Input

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	1
Max. Number of Modules:	any

MODBUS Analog Output

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any, but only 1st sample of block is output
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	any

Data type

Specify the type of data returned by the device: The data will need to be scaled by setting the data range.

- Unsigned Int: Data is returned by the device in the range 0 to 65535
- Signed Int: Data is returned by the device in the range -32767 to +32768

Data Range

Set the minimum and maximum value (engineering units) returned by the device. Unsigned Int will return an integer value between 0 … 65535, Signed Int will return an integer value between -32767 … +32768. The integer value is then scaled based on the Minimum - Maximum range. Select Raw Data to output the actual integer value.

Device

Address: Specify the address of the attached MODBUS device in hexadecimal (1… FF).

Register: Specify the Register within the device. Choose 30 or 40 to select the range 30000 – 300FF or 40000 – 400FF and then select from 1 to FF to specify the sub range.

Test:

Click on the Test Button to attempt communication and show the data in a pop-up dialog box.

MODBUS Setup

This dialog box allows you to define the parameters for the COM port used by ***ServiceLab***. The default settings are COM1, 300 baud, 7 data bits, 1 stop bits, 0 sec. Transmit Delay and 1 sec. Receive Delay.

If MODBUS Input and Output modules use the same COM Port, these settings are used by all.

Com Port Settings

- Com. Port: Specify the communications port to be used. Valid choices are COM 1 to COM **32**. The com port must exist on your computer.

- Baud rate: Define the speed of the communications device from 300 Baud to 115200 Baud.
- Data bits: Define the number of data bits (7 or 8).
- Stop bits: Define the number of stop bits (1 or 2)
- Parity: Define whether an additional parity bit per character is used. Choices are even, odd or none.
- Enable CTS: Uses the control lines of the serial interface for hardware handshake.
- Transmit Delay: Specify, in seconds, the delay before the data is transmitted to the MODBUS device.
- Receive Delay: Specify, in seconds, the delay after timeout. If a device does not respond within the specified, ***ServiceLab*** will display an error.

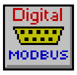
Timing

Define the sampling rate for this module in seconds. Timing will be rounded down to the next appropriate value if the sample rate is too fast.

Error Handling

If a device does not respond within the defined Receive Delay, you can choose whether to Ignore the Module or Stop Program.

20. MODBUS Digital Input and Output Modules (optional)



Use this module to ***acquire digital data from industry-standard MODBUS device****.*

What is Modbus?

MODBUS® Protocol is a messaging structure developed by Modicon in 1979, used to establish master-slave/client-server communication between intelligent devices. It is a de facto standard, truly open and the most widely used network protocol in the industrial manufacturing environment... For more information about Modbus please see http://www.modbus.org or check either the Modbus Library or the FAQs

Supported MODBUS Functions

MODBUS Analog Functions 0x1, 0x3, 0x4, and Digital Functions 0x10, and 0xF are supported.

MODBUS Digital Input

Input and Output Characteristics

Number of Inputs: ---
Input Block Size: ---

Number of Outputs: up to 16
Output Block Size: 1
Max. Number of Modules: any

MODBUS Digital Output

Input and Output Characteristics

Number of Inputs: up to 16
Input Block Size: any, but only 1st sample of block is output
Number of Outputs: ---
Output Block Size: ---
Max. Number of Modules: any

Device

Specify the Address in hexadecimal (1… FF) of the attached MODBUS device.

Specify the Starting Byte within the device.

Test

Click on the Test Button to attempt communication and show the data in a pop-up dialog box.

MODBUS Setup

This dialog box allows you to define the parameters for the COM port used by ***ServiceLab***. The default settings are COM1, 300 baud, 7 data bits, 1 stop bits, 0 sec. Transmit Delay and 1 sec. Receive Delay.

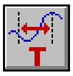
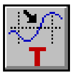
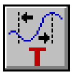
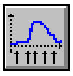
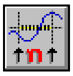
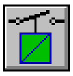
If MODBUS Input and Output modules use the same COM Port, these settings are used by all.

See page 3-69 for details of each setting.

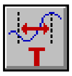
Chapter 4
Trigger Functions

Chapter 4: Trigger Functions Module Group

This group consists of the modules for software triggers.

	Module	Basic version	optional
	**Combi Trigger**	x	
	**Pre/Post Trigger**	x	
	**Start/Stop Trigger**	x	
	**Trigger on Demand**		x
	**Sample Trigger**	x	
	**Relay**	x	

1. Combi Trigger Module



Use this Trigger module for continuous signal supervision It generates a trigger signal at its output based on the input signal conditions.

The module can keep up to 16 signal inputs and creates a unique TTL compatible output signal to input to other modules. You can define the number of channels with the channel bar. All other parameters describe the behavior of the output signal, under those conditions the output switches to high (5V) or low (0V). The output may be routed as a control signal to a Relay module, which can be used cut off the data of all inputs when the control signal is low.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs (data signals)
Input Block Size:	any, but the same for each pair
Number of Outputs:	number of inputs divided by 2 (TTL signals)
Output Block Size:	same as input block size
Max. Number of Modules:	any

Define a start and a stop condition to cut off all uninteresting segments of a signal. When the start condition occurs, the trigger is active and the output signal switches to high and stays high until the stop condition occurs. You can expand the time interval of the trigger activity using pre-trigger and post-trigger for samples acquired before the start condition event and after the stop condition event has occurred. Start and stop conditions can be defined with a minimum time in which the condition does not switch the trigger activity. This allows application of time hysteresis and the separation of signal fragments of interest.

Start/Stop Conditions:

Direct
Sample greater than specified level
Sample less than the specified level
Signal rises above the specified level
Signal falls below the specified level
Rising TTL edge
Falling TTL edge
Never (Stop Condition only)

These conditions are completed by real level values.

- The Pre-trigger parameter allows you to route the defined number of samples that precede the Start Condition through a Relay. The maximum number of Pre-trigger samples is 8192 and the minimum is zero. Post-trigger defines the number of samples after the Stop Condition event. You can choose a Post-trigger count between 0 and 4 million samples.

- Minimum duration defines the count of samples the trigger remains active regardless of the stop condition. The stop condition is ignored until after the defined minimum duration time.
- The Minimum Delay at Low Time defines the time the Start Condition is ignored after the trigger output switches to low. You can choose both counts between 0 and 4 million samples.

1.1. Trigger Applications

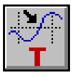
This trigger module allows you to separate interesting signal segments. You define the signal regions of interest by defining a Start and a Stop Condition. The trigger may be used in conjunction with a relay and a display module for triggered display as used in oscilloscopes.

Example: Use the Start Condition Signal Grows Above Level 0 and the Stop Condition Signal Falls Below Level 0, to cut off all negative samples.

You can expand the segment of interest by using pre-trigger and post-trigger values to get information about the input signal transition when passing the Start and Stop Condition. When you know that nothing can happen for a defined time after trigger completion, you may lock the Start Condition using the Minimum Delay At Low State parameter. The same mechanisms may be used when you visualize fast-acquired periodic signals and need not process every trigger condition. The Minimum Duration At High State works the same at high state, providing larger segments of interest.

⇨ *The Combi Trigger module only operates well when the acquisition rate is greater than three times the highest signal frequency. Otherwise, checking the start and stop conditions will create aliasing effects. Usually, applications must acquire the signal faster than this, so this restriction should not be an issue.*

2. Pre/Post Trigger Module



***Use this module to generate a trigger signal at its output depending on the input signal conditions*.**

Module Configuration

For each signal input, different range conditions regarding the amplitude or the slope may be defined. To avoid multiple triggering, define a hysteresis.

Input and Output Characteristics

Number of Inputs:	up to 16 (data signals)
Input Block Size:	any
Number of Outputs:	same as number of inputs (TTL signals)
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module generates a TTL compatible signal at each module output. The output signal is dependent on the trigger conditions defined for the corresponding module entry. Its value is set too high (amplitude 5) if the trigger condition is fulfilled, and it is set to low (amplitude 0) if the trigger condition fails.

The output signals can be used to control a Relay module that controls the signal flow.

- The Trigger Range defines the range of amplitude values that will cause the trigger to be set.
- The Trigger Hysteresis defines the condition that has to be fulfilled before a second trigger event will be accepted.

  Both conditions consist of two parts: the definition of an amplitude or slope range, and whether a trigger should be set when the signal is inside or outside the defined range.
- The Pre and Post Trigger Values define how many high values will be set at the corresponding module output and in which way these values are related to the actual position of the trigger event itself.
  - The Pre Trigger Value defines how many samples of the output will be set to high directly before the trigger event.
  - The Post Trigger Value defines the number of high samples after the trigger event. The duration of the trigger high phase is simply the sum of the Pre and Post Trigger Values.

  Allowed values are between 0 and 8192 for the pre trigger and between 1 and 65535 for the post trigger.

Unlike the Start/Stop Trigger module, this module allows you to control the signal flow continuously. Also see the Combi Trigger description. It allows you to control the signal flow continuously based on Start and Stop Conditions.

Trigger Range

The trigger range defines the trigger mode and the upper and lower limits.

If an amplitude trigger is used, the incoming data samples will be checked against the specified upper and lower trigger value levels.

- Inside will generate a high level output if the signal amplitude enters or is within the specified upper and lower limits, or is equal to these limit values themselves.

- Outside will generate a high level output if the signal amplitude leaves or is outside the specified value range.

If a slope trigger is used, the slope of the incoming data samples is used instead of the amplitude itself. The slope is calculated as the difference between two successive samples divided by their time difference. For example: value 1: 3.5, value 2: 3.6, sampling rate: 100 Hz = 0.01 sec.

⇨ Slope:

After the measurement has been started, a trigger event will only be detected and evaluated if the following conditions are fulfilled:

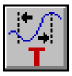
- The defined number of pre trigger values must be available,
- For the second and all subsequent trigger events the Hysteresis conditions must be fulfilled.

2.1. Hysteresis

This option defines the trigger module's reaction after a trigger event has occurred. Use this function to prevent unwanted multiple triggers.

- If Hysteresis is switched off, the trigger will be activated immediately after the defined number of post trigger values has passed the module.
- If Hysteresis is switched on, the hysteresis condition must be fulfilled before the trigger will be activated again. The options for Hysteresis definition are the same as for Trigger Range.

3. Start/Stop Trigger Module



This module controls the entire measurement by generating a continuous high or low signal at its output that is dependent on the input signal conditions (amplitude or slope).

This module switches the output signal only once (from high to low, or from low to high), making it suitable for starting or stopping further analysis of the signal.

Module Configuration

Different trigger conditions and Trigger Ranges may be specified for each signal input.

Input and Output Characteristics

Number of Inputs:	up to 16 (data signals)
Input Block Size:	any
Number of Outputs:	same as number of inputs (TTL signals)
Output Block Size:	same as input block size
Max. Number of Modules:	any

After the measurement has been started, the signals at the module entries are checked against the specified Trigger Conditions. If the condition is fulfilled, the output signal will be switched. Every input sample will then cause a TTL compatible output sample.

The input signal has to be a continuous data stream; triggered data is not valid

- In case of a Start Trigger, this value will be low (amplitude 0) before the condition is fulfilled, and high (amplitude 5) afterwards.
- In case of a Stop Trigger, the output signal will be high (amplitude 5) before the condition is fulfilled, and low (amplitude 0) afterwards.

You cannot reset this module during measurement.

The output signals can be used to control a Relay module, which may gate the signal flow, or as the input of a Stop module, which may stop or pause the measurement.

Trigger Range

The trigger range defines the trigger mode and the upper and lower limits.

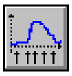
If an Amplitude Trigger is used, the incoming data samples will be checked against the specified upper and lower trigger value levels.

- Inside will generate a high level output if the signal amplitude enters or is within the specified upper and lower limits, or is equal to these limit values themselves.
- Outside will generate a high level output if the signal amplitude leaves or is outside the specified value range.

If a slope trigger is used, the slope of the incoming data samples is used instead of the amplitude itself. The slope is calculated as the difference between two successive samples divided by their time difference. For example: value 1: 3.5, value 2: 3.6, sampling rate: 100 Hz = 0.01 sec.

⇨ Slope: $\frac{3.6 - 3.5}{0.01} = 10$

4. Trigger on Demand



***This module generates TTL Level triggering on the course of the signal curve, evaluating the dynamics of the signal. By using the relay module with this trigger, you can rebuild an approximation of the signal with only few samples*.**

The parameters define the moment the module gives a TTL High (5V) pulse to the Output channel.

Input and Output Characteristics

Number of Inputs:	up to 16 (Data signals)
Input Block Size:	any
Number of Outputs:	same as Input (TTL signals)
Output Block Size:	same as Input
Max. Number of Modules:	any

The Trigger function checks the variation of the input data. The defined deviation interval marks the area in which consecutive values may differ without triggering. The value to compare is the last value that violates the limits of this interval. At the start of experiment, the first trigger is set and the first received value is used as reference. If the deviation of the values crosses the limits, two TTL high values are sent to the output: the first at the previous value, the second at the actual value.

4.1. Trigger Condition

Deviation +/-: XX: This setting defines the allowed deviation of consecutive values. If the absolute value of the difference of the samples is out of the allowed limits, the module generates the trigger. Use a small deviation to rebuild the curve more exactly, but the number of trigger (samples) will increase.

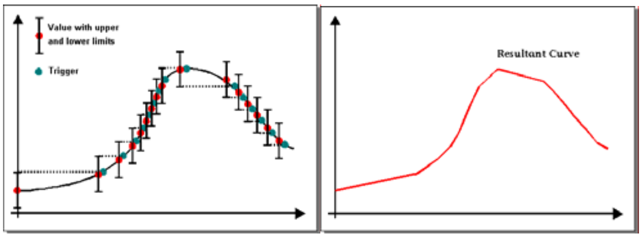
4.2. Option

Check Sign Inversion

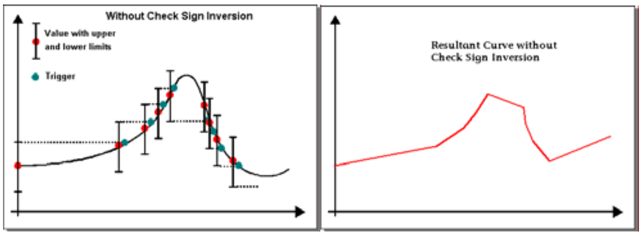
This option allows you to check whether the sign of the difference of values ($y_1 - y_0$) changes. If the sign changes, the module generates an additional trigger. So you can amend the reproduction of curve at the inflection point.

Do not use this option if the signal is noisy, because each sign inversion would cause a new trigger.

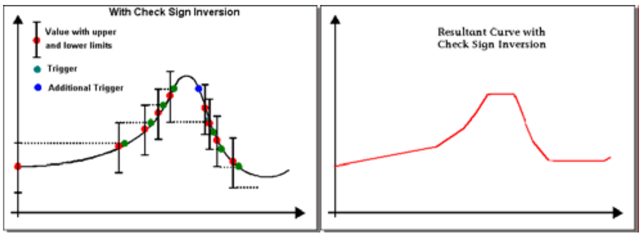
4.3. Function of the Trigger on Demand



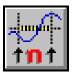
4.4. Function without Check Sign Inversion



4.5. Function with Check Sign Inversion



5. Sample Trigger



This module is used to generate a trigger signal at its output depending on the input signal conditions.

In the worksheet, this module can have up to **16** signal inputs.

The parameters define the moment the module gives a TTL-High (5V) pulse to the Output channel. The output may is used to control an Action Module to activate a special operation.

Input and Output Characteristics

Number of Inputs:	up to 16 (Data signals)
Input Block Size:	any
Number of Outputs:	same as Input (TTL signals)
Output Block Size:	same as Input
Max. Number of Modules:	any

This Trigger function takes a defined number of samples. Two different modes of the Trigger allow you to initiate a Trigger at three different moments.

Trigger conditions

Input is:

- **Greater** than threshold value
- **Less** than threshold value
- **TTL-High**
- **TTL-Low**
- Is **between** a defined bound
- Is **out of** a defined bound

You have to define limit values or range of values

5.1. Trigger modes

5.2. Trigger condition is fulfilled by more than XXX values

- Trigger moment at start of the Trigger event

  Start of the Trigger operation is the moment that the defined Trigger condition is fulfilled. The module will then wait for the defined number of values. If the Trigger condition is still fulfilled, one TTL-High value is output out at the moment the condition is fulfilled for the first time. Unless the condition is fulfilled a new trigger event can start again.
- Trigger moment at stop of the Trigger event

  Start of Trigger operation is that moment that the Trigger condition is fulfilled. Then the module will wait for the defined number of values. If the Trigger condition is still fulfilled, one TTL-High value is output at the moment the condition is no longer fulfilled.
- Trigger moment XXX values after start of the Trigger event

  Start of the Trigger operation is that moment that the defined Trigger condition is fulfilled. Then the module will wait for the defined number of values. If the Trigger condition is still fulfilled, one TTL-High value is

output out at the moment the defined number of values is reached. Unless the condition is fulfilled, a new trigger event can start again.

5.3. Trigger condition is fulfilled less than XXX values

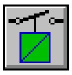
- Trigger moment at start of the Trigger event

  Start of the Trigger operation is that moment that the defined Trigger condition is fulfilled. Then the module waits for the defined number of values. If the Trigger condition stays unfulfilled during this period, one TTL-High value is output out at the moment the condition is fulfilled for the first time.
- Trigger moment at stop of the Trigger event

  Start of the Trigger operation is that moment that the defined Trigger condition is fulfilled. Then the module will wait for the defined number of values. If the Trigger condition stays unfulfilled during this period, one TTL High value is output out at the moment the condition is no longer fulfilled.
- Trigger moment xxx samples after start of the Trigger event

  Start of the Trigger operation is that moment that the defined Trigger condition is fulfilled. Then the module will wait for the defined number of values. If the Trigger condition stays unfulfilled during this period, one TTL High value is output out at the moment the defined number of values is reached.

6. Relay Module



This module can control several data streams using one control input.

This module can have up to **15** signal inputs and one control input.

Input and Output Characteristics

Number of Inputs:	1 control input, up to 15 signal inputs
Input Block Size:	any
Number of Outputs:	up to 15 (same as signal inputs)
Output Block Size:	same as input block size
Max. Number of Modules:	any

Before you insert the Relay module into a worksheet you have to select one of the allowed function modes.

Choose the first mode where the Relay module controls the data stream from its signal inputs using its control input. The control signal must be TTL compatible.

- If the control signal is TTL high, data at the signal inputs can pass to the module outputs.
- If the control signal is TTL low, the behavior of the module depends on the settings in Blocked Data. If Remove is chosen, the flow of data will be stopped; if Replace with Zeroes is chosen, the data not belonging to a trigger event are replaced with zeroes.
- Choose Invert Control Signal to switch the operation of the Relay. TTL low allows data to pass to the module outputs, while TTL high will stop or replace the data with zeros, as specified in the dialog box.
- With Remove, the Relay module rearranges data blocks in such a way that it will always try to send out complete blocks of the global block size. If the control signal switches very quickly, the number of blocks at the output side of the module may be greater than at the input side. The data is tagged as triggered data blocks, and the number of samples in the blocks may be smaller than the specified Experiment Setup Block Size.
- With Replace with Zeroes set, the Relay module does not rearrange any data blocks. This setting is very useful to combine triggered data channels with "normal" data channels. On the other hand there is no data reduction as with Remove.
- The control input is tagged **x**.

Or, choose the second mode where the Relay module is controlled by Event Driven Actions. In this mode the module has up to 16 input and output channels. The behavior (Pass signal or stop data flow) is triggered by an event. Use the Action module to define the events and action.

The Relay module is useful when combined with the Start/Stop Trigger, the Pre/Post Trigger, the Time Slice, and the Digital Input modules. It can also be used in conjunction with the Switch, Logical Operations, and Formula modules to control the data flow within a worksheet.

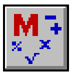
Chapter 5
Mathematics

Chapter 5: Mathematics Module Group

This group consists of modules that perform mathematical functions.

Module	Basic version	optional
Formula Interpreter	x	
Arithmetic	x	
Trigonometry		x
Scaling	x	
Differentiation Integration	x	
Logical Operations	x	
Bit Logic	x	
Channel Coparioson	x	
Flip-Flop	x	
Gray Code		x
Slope Limitation	x	
Reference Curve	x	

1. Arithmetic Module



The arithmetic module performs basic calculations with one or more input signals.

Since this module provides different basic operations, you must first select the function type when you install the module. This module provides **four** function types:

Operation with One Operand: Inverse, square, square root and other calculations.

Operation with One Operand and a Constant Value: Multiplication with a constant value, offset definition and other calculations.

Operation with Two Operands: Basic signal arithmetic including addition and multiplication of signal values from two channels.

Operation with Two or More Operands: Functions that apply to two or more operands, including addition, AND, OR, minimum, maximum, and mean.

Overview

Once this module is placed onto the worksheet, its module configuration dialog box will provide only the settings and options for the selected type. If you wish to specify another type, delete the module and install it again choosing the new type.

Since this module performs several basic operations, the selection of the module type also determines the number and function of the module entries. The number of module entries can be specified using the Channel Bar.

For Operation with One Operand, Operation with One Operand and a Constant Value and Operation with Two or More Operands, a maximum of **16** module entries is available. Operation with Two Operands allows up to **8 pairs** of module entries.

If illegal calculations occur, such as division by zero, or in case of an overflow, this will be indicated in all display functions by strings like `E_NUM`, `E_MAX` or `E_MIN`. However, the running measurement and analysis will not be stopped.

1.1. Arithmetic Operation with One Operand

This type performs inverse, square, square root and other calculations on one channel's values.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size

Max. Number of Modules: any

This module performs the following (Channel = input signal value):

Function	Output Value
Inverse	one divided by Channel (reciprocal)
Square	Channel multiplied by itself
Square Root	square root of the absolute value of Channel
Absolute Value	absolute value of Channel
exp (x)	e to the power of Channel
ln (x)	natural (base e) logarithm of the absolute value of Channel
lg (x)	decimal (base 10) logarithm of the absolute value of Channel
log (x)	binary (base 2) logarithm of the absolute value of Channel
Sum (x)	sum of input values (sum of all samples since last reset)
Difference (x)	difference from the proceeding input value
NOP	Channel (no operation)

Running values can be reset during an experiment using the Event Driven Actions.

1.2. Arithmetic Operation with One Operand and Constant

This arithmetic module performs calculations with one signal and one constant value, such as multiplication by a constant value.

Input and Output Characteristics

Number of Inputs: up to 16
Input Block Size: any
Number of Outputs: same as number of inputs
Output Block Size: same as input block size
Max. Number of Modules: any

The constant value must be entered in the field in the right half of the dialog box. This module performs the following calculations (Channel = input signal value):

Function	Output Value
Channel = Constant	Channel equal to constant
Constant + Channel	constant plus Channel (Subtraction: Add a negative constant)
Constant * Channel	constant multiplied by Channel
Constant ^ Channel	constant to the power of Channel
Channel ^ Constant	channel to the power of constant
Channel / Constant	channel divided by constant
Channel mod (c)	remainder when dividing Channel by constant
Extract bit	TTL compatible high, if the corresponding bit is set for the represented integer, TTL compatible low otherwise
NOP	output equal to Channel (no operation)

1.3. Arithmetic Operation with Two Operands

This arithmetic module performs calculations with two signals, such as addition and multiplication of signal values from two channels.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	any
Number of Outputs:	up to 8 (same as input pairs)
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module performs the following basic calculations:

Function	**Output Value**
Channel + Channel	Channel 0 plus Channel 1
Channel * Channel	Channel 0 multiplied by Channel 1
Channel – Channel	Channel 0 minus Channel 1
Channel / Channel	Channel 0 divided by Channel 1
Channel ^ Channel	Channel 0 to the power of Channel 1

1.4. Arithmetic Operation with Two or More Operands

This arithmetic module performs calculations with two or more signals, such as addition and multiplication of signal values from six channels.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any, but the same for all entries
Number of Outputs:	1
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module applies the chosen function to all of the input channels. The result of the operation is contained in the output signal. All operations are performed sample by sample.

This module performs the following basic calculations:

Function	Output Value
Add	sum of all input channels
Multiply	product of all input channels
OR	if any input is high, output is high
AND	if all inputs are high, output is high
Max/Min	maximum or Minimum of all input channels
Mean	the mean value of all input channels
Abs. Value	the square root of the sum of the squares of all input channels

2. Trigonometry Module (optional)

This module performs trigonometric calculations on the input signals.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

For each module entry one of the following functions can be selected:

Sine / Cosine

The output values are calculated as sine or cosine functions of the input signal values. The output range is from -1 to 1. Input values greater than 10E7 cannot be calculated due to rounding errors of the underlying processor functions.

Tangent

The output values are calculated as tangent functions of the input signal values. The output signal is not bounded.

The tangent function will be defined for all input values except

- $$\pm\frac{\pi}{2}, \pm\frac{3\pi}{2}, \pm\frac{5\pi}{2}, \ldots$$

ServiceLab will replace these values with values slightly larger or smaller. Input values greater than 10^7 cannot be calculated due to rounding errors of the underlying processor functions.

ArcSine / ArcCosine

The output values are calculated as arcsine or arccosine functions of the input signal values, for example, the inverse functions of sine and cosine. Both func-

tions will only be defined for input values between –1 and 1. For all other values ***ServiceLab*** will set the output value to 0.

ArcTangent

The output values are calculated as arc tangent functions of the input signal values, i.e., the inverse function of tangent.

The arctangent function will be defined for all input values.

- Output values will range from $-\frac{\pi}{2}$ to $\frac{\pi}{2}$.

Hyperbolic Sine / Hyperbolic Cosine / Hyperbolic Tangent

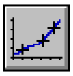
The output values are calculated as hyperbolic functions (**sinh**, **cosh**, or **tanh**) of the input signal values. They will be defined for all possible input values, but since they are based on the exponential function the results may cause overflows or rounding errors.

The definitions of the hyperbolic functions are:

- $\sinh(x) = \frac{e^x - e^{-x}}{2}$, $\cosh(x) = \frac{e^x + e^{-x}}{2}$, $\tanh(x) = \frac{\sinh(x)}{\cosh(x)}$.

The input signals can either be interpreted as degree or radian values. The appropriate unit must be selected in the dialog box.

3. Scaling Module



Use this module to apply different scaling methods to the signals from the module entries.

Since this module provides different basic operations, you must first select the function type when you install the module.

This module provides **three** function types:

Linear Scaling with Two Points: Use this type to perform linear scaling.

Interpolation using a Table: Use this type to linearize input data by performing an interpolation between different values entered in list form.

Thermocouple Linearization: Use this type to perform predefined linearization for different types of thermocouples.

PT 100 / Ni 100 – Linearization

Offset Adjustment

Overview

Once this module is integrated into the worksheet, its module configuration dialog box will provide only the settings and options for the selected type. If you wish to specify another type, delete the module first, and install it again choosing the new type.

Since this module performs several basic operations, the selection of the module type determines the number and function of the module entries. The number of module entries can be specified using the Channel Bar. For all types a maximum of 16 module entries is available. These can perform different functions of the same type on the input signals.

If illegal calculations occur, such as division by zero, or in the case of an overflow, this will be indicated in all display functions by strings like `E_NUM`, `E_MAX` or `E_MIN`. However, the running measurement and analysis will not be stopped.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

These characteristics are the same for all the three module types.

3.1. Linear Scaling

You can select one of the following types of linear scaling:

Slope and Offset

Values are calculated according to the formula Y = ax + b.

Definition of Two Points

A linear scaling with two reference points (X1, Y1) and (X2, Y2) is performed. In this case offset and slope are calculated automatically:

- $a = \frac{Y_1 - Y_2}{X_1 - X_2}$ a = (Y1 – Y2) / (X1 – X2)
- $b = \frac{Y_1 - (Y_1 - Y_2)}{X_1 - X_2} * X_1$ b = Y1 – (Y1 – Y2) / (X1 – X2) ∗ X1

Off

This function does not calculate on the input values except that they may be cut to the defined upper and lower limits (no operation).

In addition, upper and lower limit values can be defined. If the output signal exceeds these levels, it will be cut to the respective values.

Unit Conversion

Use this option to convert your data value from one unit system to another. You can convert in the following areas using standard conversion factors.

Temperature	Volume	Pressure

Length	Mass	Velocity
Acceleration	Area	Time
Power	Energy	Force
Density	Flow Rate Volume	Flow Rate Mass
Viscosity	Angle	Bits/Bytes,
Illuminance	Luminance	

The unit assigned to the input signal is selected in From:, the target units in To:.

3.2. Interpolation

This module type requires a reference file with pairs of corresponding input and output values. The file format is explained in detail in Chapter 5 of the User Guide.

The input values will be interpolated according to the pairs of reference values. Between these values a piecewise linear interpolation is performed.

If an input value is outside the range defined by the input value table (i.e., by the maximum and minimum values of the first column), the value corresponding to the maximum or minimum value of the first column will be output.

The reference file can be entered in the dialog box that appears after pressing the Open button. The file extension must be .DPF.

You can choose between a one-channel and a multi-channel type of reference file. If multi-channel is selected, all channels use only one reference file, if one-channel is activated, separate reference files are assigned to each channel. If there are more channels in the module than are defined in the assigned multi-channel reference file, you can use the partitional linearization option to interpolate the channels 0 to number of channels defined in reference file. Extra channels are not linearized (NOP function is activated).

Use the close/open Action to switch between several reference files while measurement is running.

You can specify a standard directory for reference files (Options menu command).

3.3. Thermocouple Linearization

This module type allows the linearization of temperature signals generated by different types of thermocouples. For proper operation, the data acquisition hardware must be capable of measuring low voltages, and the correct type of thermocouple must be used.

ServiceLab uses its own linearization tables, which are slightly different for each type. The input voltage is converted to a value that represents the temperature in degrees centigrade.

Cold junction compensation can be integrated in different ways:

Auto: Some data acquisition devices allow direct cold junction temperature measurement. In that case, the cold junction mode should be set to Auto. ***ServiceLab*** will automatically take the cold junction temperature provided by the device.

Manual: The manual setting provides a constant environmental temperature by heating or cooling the junction point. In this case the temperature can be passed on to ***ServiceLab*** for correction of the temperature value.

Off: Cold junction compensation can also be switched off completely (the default setting).

3.4. Pt 100/Ni100 Linearization

This module converts the resistance variation of a thermosensitive resistance into temperature. ***ServiceLab*** supports the **Pt100 and Ni100** types. You need data acquisition hardware that enables measurement with thermosensitive resistance and a constant current source.

The thermosensitive resistance modifies conductivity with temperature. This conductivity is independent of the type. Depending on the value of the **constant current source** there is a voltage drop at the resistance. ***ServiceLab*** uses arithmetic rules based on DIN IEC 751 (Pt100) or DIN 43760 (Ni100) to convert a voltage drop into a value that represents the temperature in degrees centigrade.

You can select one of the following types of linearization:

Pt100 (DIN IEC 751): Choose this function for Pt100 resistance.

Ni100 (DIN 43760): Choose this function for Ni100 resistance.

NOP: This function does not perform calculations on the input (no operation).

To use linearization you must define the current source, Constant Current Source. Define the current value of your source (**0.1 - 10 mA**). Default is 0,1 mA.

3.5. Offset Adjustment

The Offset Adjust Scaling Module function is used to zero the data. The incoming data is corrected by a specified amount. The zero is computed from the data itself, either via action, or computed from the first data block. Using this method, the block average is used to zero further measurements. Use event driven actions to reset the zero point.

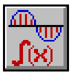
You can define an .INI file to save the zero-adjustment value. It either can be the ***ServiceLab*** (preset) or an individual INI file that must be entered in the dialog box.

Different Options settings determine how the zero adjustment value is saved:

- Read offset at Start of measurement from INI file: Reads the zero-value from the defined INI file.

- Save offset at Stop of measurement in INI file: Stores the current zero setting in the .INI file defined above for later retrieval at the start of a new measurement.
- Store offset in global variable: Save the zero-value with each change, via an event driven action or optionally after the first data block, into the specified global variable.
- Use first block of data for zero point alignment: Forces an automatic zero-alignment computed from the data of the first data block. This option can always be used if no signal is available at the start of the measurement.

4. Differentiation/Integration Module



Use this module to differentiate or integrate a signal value.

Since this module provides different basic operations, you must first select the function type when you install the module. This module provides **two** function types:

- Differentiation/Integration, controlled by Action
- Differentiation/Integration, controlled by Input

The first mode allows up to 16 data inputs, the second allows up to 15 data inputs and one control input.

4.1. Action Controlled Differentiation/Integration

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module provides **two** functions:

Differentiation: For each sample, the slope of the input signal values is calculated according to the formula

Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.,

where dist is the time delay (Δt) between two samples of the input signal. The first sample of the output signal will have the same value as the input signal.

Integral: For each sample, the integral of all the input signal values since the beginning of the experiment is calculated according to the formula **Fehler! Es ist**

nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.,

where **dist** is the time delay (Δt) between two samples of the input signal.

Restart after xxx Blocks

In addition to resetting the module (= restart of the calculation) via event-driven actions, you can trigger a restart depending on the number of processed blocks.

Each function is the inverse of the other.

Running values can be reset during an experiment using the Event Driven Actions. Note that the reset starts at the beginning of the block, and the next value output will not be zero, but will be the integral of the next block received.

4.2. Input Controlled Differentiation/Integration

Input and Output Characteristics

Number of Inputs:	up to 15, with one control input
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module provides **two** functions:

Differentiation: For each sample, the slope of the input signal values is calculated according to the formula $Y_n = \frac{X_n - X_0}{n \cdot dist}$, where **dist** is the time delay between two samples of the input signal and **n** is the number of samples in the calculation interval limited by the start/stop conditions. **Xn** are the amplitudes of the values used for calculation.

Integral: For each sample, the integral of all the input signal values since the beginning of the experiment is calculated according to the formula $Y_n = (X_0 + \ldots + X_n) * dist$,

where **dist** is the time delay between two samples of the input signal.

Options

- Start condition y1 / Stop condition y2

  The module becomes reset depending on the selected conditions. If you use the level crossing conditions you must define a value in the edit field.

  At start the output values are Zeros if the mode Difference Quotient is selected. If the condition y1 (=X0) is fulfilled, the calculation starts, if the condition y2 (=Xn) is fulfilled, calculation is halted and again Zeros are send to the output channel.

*If the condition **y1** is reached again during a running calculation, the module resets to 0 and the* 'new' ***y1*** *value is used in calculation for the Differ-*

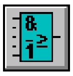
ence Quotient.

- Restart after xxx Blocks

  In addition to resetting the module (= restart of the calculation) based on the Start/Stop conditions you can trigger a restart depending on the number of processed blocks.

Both functions the Differentiation and the Integration are the inverse of the other.

5. Logical Operations Module



This module can perform logical operations with TTL compatible signals.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs or up to 16
Input Block Size:	any
Number of Outputs:	**unary** operations: same as number of inputs **binary** operations: half the number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module performs logical operations on the input signals according to the defined function. The output signal is a TTL compatible signal.

When this module is to be inserted into the worksheet for the first time, one of the following module function types may be selected:

Binary (Two Channel) Functions: FALSE, Channel a, Channel b, a and b, a or b, a xor b, a => b, b => a, a <=> b, Invert Output

Unary (One Channel) Functions: FALSE, Channel and Invert Output

Once this module is placed onto the worksheet, its module configuration dialog box will provide only the settings and options for the selected type. If you wish to specify another type, delete the module first, and install it again choosing the new type.

Since this module performs several basic operations, the selection of the module type also determines the number and function of the module entries. The number of module entries can be specified using the Channel Bar.

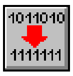
⇨ *The input signal values may differ from the exact TTL high or TTL low levels. Signals will be interpreted as **high** if their value is higher than 1.5 and as **low** if their value is equal to or less than 1.5.*

The table below indicates the values of the outputs based on the input values and the selected function.

- **0** indicates TTL Low (0V), **1** indicates TTL High (5V).
- If FALSE is selected, the output is always 0, TTL Low.

Channel:	**Input Value:**			
a:	0	0	1	1
b:	0	1	0	1
Option:	**Output Value:**			
FALSE	0	0	0	0
Channel a	0	0	1	1
Channel b	0	1	0	1
a and b	0	0	0	1
a or b	0	1	1	1
a xor b	0	1	1	0
a implies b	1	1	0	1
b implies a	1	0	1	1
a equivalent b	1	0	0	1

6. Bit Logic Module



This module interprets the input values as binary values that are represented by an input channel with 16 input bits.

The input value has to be in the range from 0 to 65535, which will be converted to the corresponding binary digits. Incoming values are rounded to integer values. If the range limits are crossed, the value is set to the appropriate limit (0 or 65535).

Since this module provides different basic operations, you must first select the function type when you install the module.

This module provides three function types:

- Mask Bits,
- Extract/Combine Bit mask,
- Link Channels bit by bit.

The module offers different numbers of input and output channels based on the selected mode.

Compared to other modules which process digital input values as TTL levels, this module also uses other values (0 up to 65535).

6.1. Bit Operation: Mask Bits

The module allows you to mask the input value as a binary word bit by bit for up to 16 signal inputs. .

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

All received data are interpreted as binary digits, defined as 16 bits.

Each input value is processed with **three operations**. The last two steps may be disabled.

- Mask Bits
- Eliminate fixed Zero bits
- Shift.

To set the first operation, you can choose bit-by-bit whether the bit is not set (0), set (1) or stays as received at input. The order of bits in dialog is from the highest (MSB, usually DI-15) on the left up to the lowest bit (LSB, usually DI-0) on the right.

The second operation allows you to automatically shift the masked binary word to the left or right, until the LSB or MSB becomes 1. The default setting is no operation.

The third operation offers a defined right or left shift of the word, which was generated by the previous operations. The default shift value is 0 (no shift).

6.2. Bit Operation: Extract/Combine bit masks

This mode allows you to output a binary word bit by bit as order of TTL Low (Bit 0) and TTL High (Bit 1) levels or to interpret received TTL levels as single bits and combine them to a binary value

Depending on the chosen mode, the module offers 1 input channel with up to 16 output channels or up to 16 inputs with only 1 output channel.

Input and Output Characteristics

Number of Inputs:	1 or up to 16, depending on mode
Input Block Size:	any
Number of Outputs:	1 or up to 16, depending on mode
Output Block Size:	same as input block size
Max. Number of Modules:	any

In the first mode, Extract Bits, the module interprets incoming values as 16 bits binary words. You can use 1 input with a maximum of 16 outputs. All bits are

sent as TTL Low (bit 0, not set) or TTL High (bit 1, set) levels to the output channels in order of their weight. The order of the bits starts with the lowest bit (LSB, usually DI-0) sent to output 0 up to the highest bit (MSB, usually DI-15) to output X. (X=number of channels-1).

In the second mode, Combine Bits, the module needs a TTL level at the input channels. You can use a maximum of 16 input channels with **1** output. The module forms a binary word using the TTL levels received at the input channels. This word is sent to the output channel. The level at input 0 is used as the lowest bit (LSB, usually DI-0), the level at channel X (X=number of channels-1) as the highest bit (MSB, usually DI-15).

⇨ *The input signal values may differ from the exact TTL high or TTL low levels. Signals will be interpreted as **high** if their value is higher than 1.5 and as **low** if their value is equal to or less than 1.5.*

6.3. Bit Operation: Link channels bit by bit

This mode performs logical operations with each bit of the received values on up to 16 input channels.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	half the number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module interprets incoming values as binary words defined by 16 bits. The data of the two input channels are converted into series of bits and become linked bit by bit with the chosen operator.

The following operators are available:

for input 0	AND	NAND	XOR
for input 1	OR	NOR	

6.3.1 Example: as Input 0 or 1

If this operator is chosen, the bits at output are the same as the bits of the selected input.

Example:		
	Value Input 0:	48352
	Value Input 1:	14879
	Operation:	as Input 1
	Output:	14879

Bit No.	***Input 0***	***Input 1***	***Output***
(MSB) 15	1	0	0
14	0	0	0

13	1	1	1
12	1	1	1
11	1	1	1
10	1	0	0
9	0	1	1
8	0	0	0
7	1	0	0
6	1	0	0
5	1	0	0
4	0	1	1
3	0	1	1
2	0	1	1
1	0	1	1
(LSB) 0	0	1	1

6.3.2 Example: AND

Example: Value Input 0: 48352
Value Input 1: 14879
Operation: AND
Output: 14879

Bit No.	*Input 0*	*Input 1*	*Output*
(MSB) 15	1	0	0
14	0	0	0
13	1	1	1
12	1	1	1
11	1	1	1
10	1	0	0
9	0	1	1
8	0	0	0
7	1	0	0
6	1	0	0
5	1	0	0
4	0	1	1
3	0	1	1
2	0	1	1
1	0	1	1
(LSB) 0	0	1	1

6.3.3 Example: NAND

Example: Value Input 0: 48352
Value Input 1: 14879
Operation: NAND
Output: 49632

Bit No.	*Input 0*	*Input 1*	*Output*
(MSB) 15	1	0	1
14	0	0	1
13	1	1	0

12	1	1	0
11	1	1	0
10	1	0	0
9	0	1	0
8	0	0	1
7	1	0	1
6	1	0	1
5	1	0	1
4	0	1	0
3	0	1	0
2	0	1	0
1	0	1	0
(LSB) 0	0	1	0

6.3.4 Example Link: XOR

Example: Value Input 0: 48352
Value Input 1: 14879
Operation: XOR
Output: 34559

Bit No.	*Input 0*	*Input 1*	*Output*
(MSB) 15	1	0	1
14	0	0	0
13	1	1	0
12	1	1	0
11	1	1	0
10	1	0	1
9	0	1	1
8	0	0	0
7	1	0	1
6	1	0	1
5	1	0	1
4	0	1	1
3	0	1	1
2	0	1	1
1	0	1	1
(LSB) 0	0	1	1

6.3.5 Example Link: OR

Example: Value Input 0: 48352
Value Input 1: 14879
Operation: OR
Output: 48895

Bit No.	*Input 0*	*Input 1*	*Output*
(MSB) 15	1	0	1
14	0	0	0
13	1	1	1
12	1	1	1

11	1	1	1
10	1	0	1
9	0	1	1
8	0	0	0
7	1	0	1
6	1	0	1
5	1	0	1
4	0	1	1
3	0	1	1
2	0	1	1
1	0	1	1
(LSB) 0	0	1	1

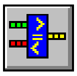
6.3.6 Example Link: NOR

Example:

Example:	Value Input 0:	48352
	Value Input 1:	14879
	Operation:	NOR
	Output:	16640

Bit No.	***Input 0***	***Input 1***	***Output***
(MSB) 15	1	0	0
14	0	0	1
13	1	1	0
12	1	1	0
11	1	1	0
10	1	0	0
9	0	1	0
8	0	0	1
7	1	0	0
6	1	0	0
5	1	0	0
4	0	1	0
3	0	1	0
2	0	1	0
1	0	1	0
(LSB) 0	0	1	0

7. Channel Comparator Module



*Use this module to **compare** a signal **input** with a constant or another channel*

Since this module provides different basic operations, you must first select the function type when you install the module.

This module provides **two** function types:

- Compare a Channel with a Constant
- Compare Two Channels

7.1. Compare Channel with a Constant

The Module compares the input signals with a predefined constant

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

Module Settings

The following settings are needed:

- Constant**:** This value is used for comparison.
- Condition: This logical condition must be fulfilled to result true (otherwise false):
  - X>Y
  - X=Y
  - X<Y

  with X = first channels and Y = second channel of a pair.
- Output Values**:** Here you define the value, that is send to the corresponding output, if the condition is fulfilled (**True**) or not (**False**).
- Hysteresis: Use the setting in hysteresis to define a range (+/-) the input may deviate from the constant to meet the condition even so.

7.2. Compare Channel with another Channel

The Module compares the input signals of two channels.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs of inputs
Input Block Size:	any
Number of Outputs:	up to 8
Output Block Size:	same as input block size
Max. Number of Modules:	any

Module Settings

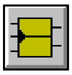
The following settings are needed:

- Condition: This logical condition must be fulfilled to result true (otherwise false):
  - X>Y
  - X=Y
  - X<Y

with X = first channels and Y = second channel of a pair.

- **Output Values:** Here you define the value, that is send to the corresponding output, if the condition is fulfilled (True) or not (False).
- **Hysteresis:** Use the setting in hysteresis to define a range (+/-) the inputs may deviate to meet the condition even so.

8. Flip-Flop Module (optional)



*The Flip-Flop Module provides several different flip-flop types. The number of the inputs depends on the chosen type and is not separately adjustable. The Flip-Flop Module always has **2 outputs.***

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

Flip-flops (also referred to as bi-stable trigger elements) are used for the intermediate storage of logical values. The function consists generally, that a flip-flop changes if a signal is received in the other condition. This condition is held until another signal changes it.

You must specify whether the incoming data is interpreted as a TTL signal or as a binary number (16 bit value).

Function

The module provides different types of flip-flops. The number of channels is dependent on the chosen type.

The switch description of a flip-flop is described by a truth table with the following key:

L	:	TTL Low or clear bit
H	:	TTL High or set bit
X	:	insignificant for the behavior
Q_0	:	last value at this output

D-Flip-Flop

Inputs: 0 → Clock 1 →Reset 2→ Preset 3→ Data

Inputs	Outputs

Preset	Reset	Clock	Data	Q	Q-bar
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H	H
H	H	H	H	H	L
H	H	H	L	L	H
H	H	L	X	Q_0	Q_0

JK-Flip-Flop

Inputs: 0 → Clock   1 → Reset   2 → J   3 → K

Inputs				Outputs	
Reset	*Clock*	*J*	*K*	*Q*	*Q-bar*
L	X	X	X	L	H
H	H	L	L	Q_0	Q_0
H	H	H	L	H	L
H	H	L	H	L	H
H	H	H	H	switch last condition	

RS-Flip-Flop

Inputs: 0 → **C**lear   1 → **R**eset   2 → **S**et

Inputs			Outputs	
Clear	*Reset*	*Set*	*Q*	*Q-bar*
L	X	X	L	H
H	L	L	Q_0	Q_0
H	H	L	L	H
H	L	H	H	L
H	H	H	Q_0	Q_0

Mono-flop

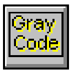
A mono-flop is a mono-stable trigger element. When receiving a signal, the mono-flop switches into an unstable state. This condition holds for the number of

the defined samples. After it the mono-flop switches back the initial (stable) state again.

Inputs: 0 → **C**lear 1 → **D**

Inputs		Outputs	
Clear	*D*	*Q*	*Q-bar*
L	X	L	H
H	L	L	L
H	H	H for x Samples, then back to L	L for x Samples, then back to H

9. Gray Code Module (optional)



This module makes possible the direct utilization of Route-/Angle-Position encoder, that uses the Gray code for the positioning information.

Input and Output Characteristics

Number of Inputs: up to 16
Input Block Size: any
Number of Outputs: same as number of inputs
Output Block Size: same as input block size
Max. Number of Modules: any

The Route-/Angle-Position encoder with Gray code produces a bit pattern that contains the information about the position

Module Settings

Gray Code Encoder Bit Width

You must specify the resolution of the encoder used (in **bits**). The number of encoded positions determines the resolution of the encoder; e.g.: 10 Bit = 2ˆ10= 1024 Positions; 14 Bit = 2ˆ14 = 16384 Positions.

Internal Optimization

- Speed: ***ServiceLab*** calculates the bit pattern of each position and writes it into a table. The program only has to read the position information from the table, rather than recalculating it for each new value.
- Memory: Use the memory option to force each position to be calculated for the incoming value. No memory is used to hold the list.

Scaling: With the Integer Scaling Option you can define Start and End **position** using the coordinates **x1, y1** and **x2, y2**. This option can be used if only a part of the maximum available mechanical encoder moving area is used in the measurement.

Options

These options affect the position calculation:

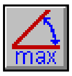
- **Absolute Value**

  The position is calculated as absolute position with the zero point of the encoder as reference.
- **Relative Value**

  The position is calculated as relative position with the zero point reference set to the encoder position when measurement starts.

Invert: Use this option to **exchange** the start position for the end position.

10. Slope Limitation Module



This module limits the slope of the input signals.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module is used to limit the slope of a section of a curve. For example, you can fade out peaks using this function. If the slope or the difference of the values is greater than the defined next value is that which is the greatest valid value. To process the first sample received, you must define a starting value to be used as a reference.

The following can be used to define the slope:

Difference between two samples: Use this setting to determine whether the difference (distance) of two consecutive values is lower than the Limit setting.

Slope per second: Use the Slope per second setting to Limit the output value. The slope is computed as the difference of two consecutive values divided by the time interval (Δt) between them.

Example: 1st value: 3.5, 2nd value: 3.6, Sampling rate: 100Hz = 0.01 sec. Δt

Slope: $\frac{3.6-3.5}{0.01}=10$

10.1. Additional Amplitude Limitation

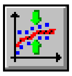
Use this setting to limit the maximum or the minimum of the allowed values. All samples with amplitudes larger or smaller than the defined values are reset to the maximum/minimum of the tolerable values.

10.2. Global Variables

You can use global variables in all modes to perform the settings. The variable used as starting value is read once, when measurement starts. All other variables are re-read at the start of each new block. (3.6 ¯ 3.5) / 0.01 = 10

Use NOP/OFF to deactivate this module; arriving samples are transmitted to the output without processing.

11. Reference Curve Module



This module calculates a Reference (Set Point) curve during a test run of your application.

These curves are useful to check set points using a tolerance band in the display modules (Y/t Chart and Chart Recorder) or in the Check Reference Curve statistics module.

In the worksheet, this module can have up to **16** signal inputs, which are used to calculate up to 16 different set-point curves.

Input and Output Characteristics

Number of Inputs:	**up to 16**
Input Block Size:	**any**
Number of Outputs:	**same as number of inputs**
Output Block Size:	**same as input block size**
Max. Number of Modules:	**any**

11.1. Function

If the NOP function is chosen, the reference curve for that channel will not be created or used. If the Generate/Update Reference Curve function is chosen, a new reference curve file is created, or, if there is an existing file with the same name, the old file will be updated.

- Each channel must have an unambiguous file name, which will contain the data of the reference curve.

This field shows the selected reference curve file and its path for the active channel (Default setting is `defname.dsk`). The File... button opens the file menu.

⇨ *If you use an **existing** reference curve file, the **new file** is calculated by using the values of the **old file and the newly** received values. This way of processing enables **the reference curve to be optimized** by running **several test runs**. If the **newly** created reference curve is **shorter than the old** file that is to be optimized, a warning is displayed.*

⇨ *The Reset Action also controls optimization of a reference curve: The active reference curve file will be closed and the subsequent data is used to optimize the reference curve.*

To create a new reference curve with the same name as an existing file you must first manually delete the old file (*name*.DSK).

- Record Time: This field defines the recording time of the reference curves. You can select Seconds, Minutes, Hours or Days for the time unit. The default setting is until Stop of Experiment: The reference curve will be recorded until the measurement stops.
- Options: If the Read/Write status --> global Variable option is active, the status is written into the specified global variable. Progress is calculated **in %** value.

11.2. Structure of the Reference Curve File

The Reference Curve file is an ASCII type file.

11.2.1 Structure

The first four lines contain general information of the reference curve and data (Comments in the following example are marked with quotes and are not a part of the file):

```
Type  = 1000  ”Y/t Data”
Number of Experiments = 19    ”Number of test runs used to cre-
ate/optimize that file”
Sample Distance       = 0.001000      ”Sampling rate”
Channel Type  = 0     ”Channel type (0=Normal)
The following lines contain the concrete data in the following order:
”Time”; ”last value”; ”Sum”; ” Sum of Squares”; ”Max value”;
”Min value”
0,000000;2315789;44.000000;304.000000;4.000000;-4.000000
0,001000;2315789;44.000000;304.000000;4.000000;-4.000000
0,002000;2315789;44.000000;304.000000;4.000000;-4.000000
....
```

These values are updated for each new test run.

12. Formula Interpreter Module

Use this module to perform custom mathematical operations.

This module can read up to **16** inputs channels and process them using the specified mathematical algorithm.

The number of inputs is chosen by the input switch, the number of output channels by the channel number Selection Bar.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	up to 16
Output Block Size:	same as input block size
Max. Number of Modules:	any

The Formula Interpreter allows you to easily process input data with user-defined formulas. The result of the operation is sent to the specified output channel.

The module allows up to 16 output channels where you can define a different operation for each channel using any of the activated input channels. The operators can be freely combined according to the specified syntax. You can also choose standard mathematical functions using the buttons (general, trigonometry, operators, constants, input) in the module properties box.

12.1. Overview: Mathematical Operands and Functions

Implemented Mathematical Operands;

+	Addition	**-**	Subtraction
*****	Multiplication	**/**	Division
>	Greater than	**<**	Less than
>=	Greater than or equal	**<=**	Less than or equal
^	Raise to a power	MOD	Modulo remainder of Division
OR	Logical OR	XOR	Logical XOR
AND	Logical AND	NOT	Logical NOT

Implemented Mathematical Functions:

`sin`	Sine	`log`	Logarithm, base ten
`arcsin`	ArcSine	`sqr`	Square
`cosh`	Hyperbolic Cosine	`sqrt`	Square root
`tan`	Tangent	`abs`	Absolute value
`arctan`	ArcTangent	`exp`	Exponential function
`sinh`	Hyperbolic Sine	`frac`	Fractional component
`cos`	Cosine	`trunc`	Truncate (integer component)
`arccos`	ArcCosine	`round`	Round
`tanh`	Hyperbolic Tangent	`rand`	Pseudo random function
`ln`	Logarithm, base e	`sign`	Sign

12.2. Order of Operations

The order of operations defines the sequence of calculation for mathematical operations. User-defined formulas will be processed according to these rules.

The rules are:

Operators	**Priority**	
`( )`	1	(first priority)
`Functions`	2	
`NOT`	3	
`^`	4	
`*, /, MOD`	5	
`+, -`	6	
`<, <=, >, >=, <>, =`	7	
`AND`	8	
`OR, XOR`	9	(last priority)

12.3. General Operation

The Formula Interpreter module (FPM) allows you to define a formula, a series of mathematical operations, to process data received at the input.

- The FPM offers a number of strings in which the user defines the desired operations. The number of strings and the combined number of operations depend on the number of Output channels activated in Channel Selection Bar.
- The corresponding module symbol in the work area will display the defined number of input **(I)** and output **(O)** symbols.
- The operations in the string are mathematical and must follow the defined syntactical rules.
- Errors in the formula will cause an error warning to be displayed.
- The formula is defined while the FPM is off-line.
- As soon as the user presses the OK button or changes focus all defined formulas are checked for syntactical and logical mistakes.

⇨ The FPM will not switch to the on-line phase unless all formulas are defined correctly.

12.4. Syntax

The Formula Interpreter module works correctly when the defined formulas follow the defined syntactical rules.

Valid inputs are numbers, constants, input channels and the implemented mathematical functions of the FPM.

Available Constants:

PI	π	(3.1415926535)
E	Euler Constant	(2.718281828)

Input channels:

IN(0) ... IN(15)

Mathematical functions:

The arguments of the mathematical functions must be enclosed by parentheses.

Functions without arguments (e.g. rand()) require empty parentheses.

Results of comparisons are **0** or **1**. To use logical results in subsequent modules, such as the Relay module, you need to multiply by **5** to obtain a TTL High (>1.5) value.

Example: Module with 4 Output channels

- string1 IN(1)*IN(2)+4*sin(IN(1)*PI)
- string2 round(sqr(IN(4))/sqrt(IN(1)))

- string3 abs(IN(1)+cosh(IN(3)))
- string4 log(IN(1))+ln(IN(3))*arctan(IN(1))

⇨ The order of operations defines the sequence of calculation for mathematical operations.

12.5. Mathematical Operands

⇨ Blanks between the function and the operators are important.

12.5.1 Addition

- Operator: +
- Explanation: Basic mathematical function of the Formula Interpreter module. Two values, m and n, are added. m and n are floating point values. The result of the Addition function is the *sum*.

12.5.2 Subtraction

- Operator: -
- Explanation: the reduction of the value by another.

12.5.3 Multiplication

- Operator: *
- Explanation: Multiple addition with the same number.

12.5.4 Division

- Operator: /
- Explanation: Division means multiple reduction of the same Subtrahend. The divided number is called the *Divisor*. The number that is divided is called the *Dividend*. The result is called the *Quotient.* The Quotient is undefined if the Divisor is zero.
- $\frac{0}{m} = 0$ for each natural number m.

12.5.5 Greater Than

- Operator: >
- Explanation: Compare two values: the result is true (1) or false (0).
- Example: 6 > 17 - 12 :true Result 1
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.6 Less Than

- Operator: <
- Explanation: Compare two values. The result is true (1) or false (0).
- Example: 5 < 17 + 3 :true Result 1
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.7 Greater Than or Equal

- Operator: >=
- Explanation: Compare two values. The result is true (1) or false (0).
- Example: 50 >= 27+ 9 :true Result 1
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.8 Less Than or Equal

- Operator: <=
- Explanation: Compare two values. The result is true (1) or false (0).
- Example: 50 <= 27+ 30 :true Result 1
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.9 Raise to a Power

- Operator: ^
- Explanation: A product built using n times the same multiplicand: m^n. m is the *Base*, n the *Exponent*.
- Example: $2 * 2 * 2 = 2^3 = 8$

12.5.10 Modulo Remainder of Division

- Operator: MOD
- Explanation: When two rational numbers are divided, the MOD function will give the remainder of the division. When a is not a multiple of b, the remainder will be non-zero.
- Example: 17 MOD 4 = 1

12.5.11 Logical OR

- Operator: OR
- Explanation: The OR function compares two statements. The statement A OR B is true if either statement A or B is true.
- Example: A = 0 (false)
  B = 1 (true)
  C = 1 (true)
  A OR B OR C = 1 (true) Result 1
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.12 Logical AND

- Operator: AND
- Explanation: The AND function compares two statements. The statement A AND B is true while statements A and B are both true.
- Example: A = 0 (false)
  B = 1 (true)
  C = 1 (true)
  A AND B AND C = 0 (false) Result 0
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.13 Logical EXCLUSIVE OR

- Operator: XOR
- Explanation: The XOR function compares two statements. The statement A XOR B is only true when one of both statements A and B is true and the other is false.
- Example: A = 0 (false) B = 1 (true)
  C = 0 (false) D = 0 (false)
  A XOR B = 1 (true) Result 1
  C XOR D = 0 (false) Result 0
- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.5.14 Logical Negation

- Operator: NOT
- Explanation: The NOT function negates a statement.
- Example: A = 0 (false)
  B = 1 (true)
  NOT A = 1 (true) Result 1
  NOT B = 0 (false) Result 0

- Hint: To use the result in another module, such as the Relay module, multiply the result by 5.

12.6. Mathematical Functions

12.6.1 Angular Function Sine

- Operator: sin(Argument)
- Explanation: The Sine of an acute angle α is a trigonometric function. The sine function is the ratio of the length of the opposite side to the length of the hypotenuse in a right triangle.
- $\sin\alpha = \frac{\text{Opposite side}}{\text{Hypotenuse}}$
- The argument of the sine function in the Formula Interpreter module is defined in radians. It has no unit. Transform degrees to radians as follows:
- $\alpha' = \frac{\alpha}{180^o}\pi$
- Example: $\sin(0) = 0$

  $\sin(\pi) = 0$ $\sin(3 * \pi) = 0$

  $\sin\left(\frac{\pi}{2}\right) = 1$ $\sin\left(\frac{3 * \pi}{2}\right) = -1$

12.6.2 Angular Function Cosine

- Operator: cos(Argument)
- Explanation: The Cosine of an acute angle α is a trigonometric function. The cosine function is the ratio between the length of the adjacent side and the length of the hypotenuse in a right triangle.
-
- The argument of the cosine function in the Formula Interpreter module is defined in radians. It has no unit. Transform degrees to radians as follows:
- $\alpha' = \frac{\alpha}{180^o}\pi$
- Example: $\cos(0) = 1$
- $\cos(\pi) = -1$ $\cos(3 * \pi) = -1$

  $\cos\left(\frac{\pi}{2}\right) = 0$ $\cos\left(\frac{3 * \pi}{2}\right) = 0$

12.6.3 Angular Function Tangent

Operator: tan(Argument)

- Explanation: The tangent of an acute angle α is a trigonometric function. The tangent function is the ratio of the length of the side opposite the angle to the length of the side adjacent to the angle in right triangle.
- The argument of the tangent function in the Formula Interpreter module is defined in radians. It has no unit. Transform degrees to radians as follows:
- $$\alpha' = \frac{\alpha}{180^o}\pi$$
- Example: tan(0) = 0

  $\tan\left(\frac{\pi}{4}\right) = 1 \quad \tan\left(\frac{\pi}{6}\right) = 0.57735$

12.6.4 Inverse of Sine Function

- Operator: arcsin(Argument)
- Explanation: The arcsine is the inverse function of a restricted trigonometric function. This type of function is also called a cyclical function. The transformation $x \to f(x)$ is not unambiguous.
- To convert trigonometric functions to inverse functions they must be restricted to parts of the rational numbers.
- $f^{-1}\colon x \mapsto \arcsin x$
  - Definition Range:
  - Range of Numbers:
  - $D = \{ x$
  - $W = \{ y \,|\, -\frac{\pi}{2}$
- Example: $\arcsin(1) = \frac{\pi}{2}$ $\arcsin(0) = 0$

12.6.5 Inverse of Cosine Function

- Operator: arccos(Argument)
- Explanation: The arccosine is the inverse function of a restricted trigonometric function. This type of functions is also called a cyclical function. The transformation $x \rightarrow f(x)$ is not unambiguous.
- To convert trigonometric functions to inverse functions they must be restricted to parts of the rational numbers.
- f^{-1}: $x \mapsto \arccos x$

❍ Definition Range:	❍ Range of Numbers:
❍ $D = \{ x$	❍ $W = \{ y \mid 0 \leq$

Example: $\arccos(1) = 0$ $\arccos(0) = \frac{\pi}{2}$

12.6.6 Inverse of Tangent Function

- Operator: arctan(Argument)
- Explanation: The arctangent is the inverse function of a restricted trigonometric function. This type of function is also called a cyclical function. The transformation $x \rightarrow f(x)$ is not unambiguous.
- To convert trigonometric functions to inverse functions they must be restricted to parts of the rational numbers.

  f^{-1}: $x \mapsto \arctan x$

❍ Definition Range:	❍ Range of Numbers:
❍ $D = \{ x \mid -$	❍ $W = \{$

- Example: $\arctan(0) = 0$

  $\arctan(1) = \frac{\pi}{4}$

  $\arctan(1000) = 0.49968\,\pi$

12.6.7 Hyperbolic Sine

- $y = \sinh(x) = \frac{1}{2}\left(e^{x} - e^{-x}\right)$
- Operator: sinh(Argument)
- Explanation: In contrast to the normal sine function, the hyperbolic sine function is not periodic. The function is symmetric centrally to the coordinate source that is also a changing point. The inclination of the tangent at zero point is $\pi/4$. The function decreases monotonically.

12.6.8 Hyperbolic Cosine

- $y = \cosh(x) = \frac{1}{2}\left(e^{x} + e^{-x}\right)$
- Operator: cosh(Argument)
- Explanation: In contrast to the normal cosine function the hyperbolic cosine function is not periodic. The function is centrally symmetric to the source coordinate. In the interval (- ¥,0] the function increases monotonically and in [0,¥) decreases monotonically. At x = 0, the function reaches the minimum value (y = 1).

12.6.9 Hyperbolic Tangent

-
- Operator: tanh(Argument)
- Explanation: In contrast to the normal Tangent function, the hyperbolic tangent function is not periodic. The function decreases monotonically; all values are between -1 and +1. The function is centrally symmetric to the source coordinate that is also changing point. The inclination of the tangent at point zero is $\pi/4$. The function decreases monotonically. Straight lines with equations y-1=0 and y+1=0 are asymptotes.

12.6.10 Square Root

- Operator: sqrt(Argument)
- Explanation: The Square Root of number b is the number a where $a^2 = b$. The number a is called the Square Root of b.
- Definition Range: $b \in R^{+}$
- Example: sqrt(9) = 3
- sqrt(16) = 4

12.6.11 Square

- Operator: sqr(Argument)
- Explanation: The square of a real number is the number multiplied by itself. The squares of real numbers are never negative.
- Example: sqr(3) = 9
- sqr(-2) = 4

12.6.12 Fraction Part

- Operator: frac(Argument)
- Explanation: The fraction function returns the number with the digits before the decimal set to zero.
- Example: frac(9.25) = 0.25

12.6.13 Truncate Fraction Part

- Operator: trunc(Argument)
- Explanation: The truncate fraction function will return the argument as an integer value by truncating the fractional part.
- Example: trunc(9.25) = 9, trunc(-9.25) = -9

12.6.14 Rounding

- Operator: round(Argument)
- Explanation: The round function will return the argument as an integer value. Numbers with the fractional component greater than or equal to 0.5 are rounded to the next greater integer number.
- Example: round(9.51) = 10
  round(9.47) = 9
  round(-0.5) = 0
  round(-0.6) = -1

12.6.15 Absolute Value

- Operator: abs(Argument)
- Explanation: The absolute value function returns the absolute value of the argument. The absolute value of a rational number is defined as:
-
- Example: abs(-9.25) = 9.25
  abs(4.3) = 4.3

12.6.16 Random

- Operator: rand()
- Explanation: The rand function returns a pseudo random number a (where $0 \leq a \leq 1$).
- Hint: You need no argument to call this function, however, you must include empty parentheses.

12.6.17 Exponential Function (Euler)

- Operator: exp(Argument)
- Explanation: The base of the exponential function is the transcendental irrational Number, the Euler constant, e=2.71828...
- The argument of the function is the power of the exponential function.
- Example: exp(1) = e = 2.71828...
  exp(3) = e * e * e = 20.0855...

12.6.18 Natural Logarithm

- Operator: ln(Argument)
- Explanation: The logarithm of x base e is that exponent y with which you must raise to the power e to get x, where e is the Euler constant (2.71828...)
- For number a R^+, the logarithm function is the inverse function of the exponential function. The result of $z = e^x$ using the function ln(z) is the value x.

12.6.19 Decimal Logarithm

- Operator: log(Argument)

- Explanation: The Logarithm of x base 10 is that exponent y with which you must raise to power a to get x.
-
- For the number a $\in$ $R^{+}\backslash\{1\}$, the logarithm function is the inverse function of exponential function. The result of $z = 10^{x}$ using the function ln(z) is the value x. Base a is the value 10.

12.6.20 Sign Function

- Operator: sign(Argument)
- Explanation: The Sign function returns the sign of the argument.
- Example: sign(-5)=-1
- sign(5) =+1

12.7. Error messages

Error 1	Type of error:	unexpected end
	Explanation:	The input string is not complete. The parser detects an unexpected end of input. Is an operand is missing?
	Example:	1 + ...
	Correction:	Insert the missing operand or string: a constant, an implemented function, a number or an Input channel.
Error 2	Type of error:	too many numbers
	Explanation:	This error occurs when too many numbers are defined as operands in the formula.
	Example:	1+2+3+4+...+n
	Error:	n > 256
	Hint:	n is the number of operands not the value of them.
	Correction:	Reduce number of operands (< 256).
Error 3	Type of error:	no variables permitted
	Explanation:	This error occurs when symbols are used as variables in formula. Place markers for variables are not allowed in FPM.
	Example:	3+x*4+y
	Correction:	Delete place markers x and y.

Error 4	Type of error:	unknown character
	Explanation:	This error occurs when characters used in the formula are not supported.
	Example:	ö,ä,ü, etc.
	Correction:	Delete the unsupported characters.
Error 5	Type of error:	memory error
	Explanation:	Free memory is running Low. The Formula Interpreter Module is not able to create the needed structures to process the formula.
	Correction:	First try to reduce complex formulas. A better solution is to increase the size of available memory by closing other applications, etc. If this continues to be a problem, contact your distributor.
Error 6	Type of error:	too many characters
	Explanation:	The numbers or function names have more decimal points than allowed.
	Correction:	Review the syntactical rules of FPM and delete all signs that do not agree with rules.
Error 11	Type of error:	wrong operator
	Explanation:	This error occurs when illegal combinations of types are found as operators in the formula: Syntax error!
	Correction:	Check formula for input errors and syntactical rules.
Error 18	Type of error:	')' expected
	Explanation:	Parentheses are not complete. All opened parentheses must be closed.
	Correction:	Check formula for parentheses mismatches.
Error 19	Type of error:	Parameter error
	Explanation:	Formula contains a mathematical function without the needed argument.
	Example:	sin()
	Correction:	Insert the missing argument between the parentheses.
Error 20	Type of error:	unknown function
	Explanation:	An unimplemented mathematical function was

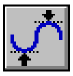
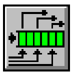
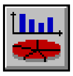
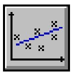
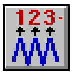
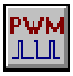
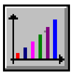
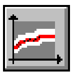
		found. This error occurs when there is a mistake in the function name.
	Example:	sib(IN(1)) instead of sin(IN(1))
	Correction:	Check function names for mistakes.
Error 21	Type of error:	'(' expected
	Explanation:	When using implemented mathematical functions, you need to use parentheses correctly. The argument of this function must be within parentheses. The (may be missing.
	Example:	sin 0)
	Correction:	Insert missing parentheses.
Error 22	Type of error:	')' expected
	Explanation:	When using implemented mathematical functions you need to use parentheses correctly. The argument of this function must be within parentheses. The) may be missing.
	Example:	sin (0
	Correction:	Insert missing parentheses.
Error 26	Type of error:	Input Channel wrong
	Explanation:	A maximum of 16 input channels is available in Formula Interpreter Module. The formula has used an input channel number greater than 15. (Range of channels: IN(0) ... IN(15)).
	Example:	IN(18)
	Correction:	Use only available channels (IN(0) ... IN(15)).
Error 27	Type of error:	')' expected
	Explanation:	You cannot use another function to calculate the number of the input.
	Example:	IN(2+5) instead of IN(7)
	Correction:	The argument of the input operator is only one number. Replace the string with a single number (0-15).

Error 28	Type of error:	Input Channel not available
	Explanation:	Only activated input channels are allowed in the formula.
	Example:	IN(2) is used in formula, but only IN(0) and IN(1) are activated.
	Correction:	Activate used channels in channel input switch or delete the operator inside formula.
Error	Type of error:	Internal error
7, 8, 9,10, 12, 13, 25,	Explanation:	An error has occurred that prevents parsing of the formula.
	Correction:	Please call your distributor!
Error	Type of error:	Reserved
14, 15,16, 17, 23, 24,	Explanation:	You tried to use functions that will be implemented in a later version of the Formula Interpreter Module.
	Correction:	Please call your distributor!

Chapter 6
Statistics

Chapter 6: Statistics Module Group

This group consists of modules performing statistical functions.

	Module	Basic version	optional
	**Minimum/Maximum**	x	
	**Statistical Values**	x	
	**Position in Signal**	x	
	**Histogram**	x	
	**Regression**	x	
	**Counter**	x	
	**Pulse Width Analysis (PWM)**		x
	**Sort Channels**		x
	**Check Reference Curve**	x	

1. Min/Max Module

Use this module to find minima and/or maxima in the data stream.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	1
Max. Number of Modules:	any

This module checks the incoming data for minima and/or maxima and transfers the data to the activated output channel. In contrast to the Statistical Values module, which only provides one data point per block, this module recognizes more than one extreme in a single block.

The Operation switch selects the mode of the activated channel.

- Minima: Only minimums are recognized and transferred.
- Maxima: Only maximums are recognized and transferred.
- Minima and Maxima: The Minimum and Maximum are recognized alternately and transferred.

When the Minima and Maxima mode is chosen, use Start to define which value (Maximum or Minimum) is the beginning value. When another mode is activated these fields are grayed out and not available.

1.1. Output mode

- Function Value: Only recognized Minima and/or Maxima are transferred to the module outputs. Between these values are no values put out, so the data stream will be interrupted by gaps.
- TTL Peak: In TTL Peak mode the module outputs are set to a TTL High level (+5.0) for each recognized Maximum and (or) Minimum of the input data. 0.0 replaces any other values. In contrast to the Function Value mode, this mode produces a continuous stream of data without gaps and shortened blocks. Trigger data or spectral data is not allowed as inputs for this mode.

⇨ The generated block is transferred to the output of the module only if the complete input function is checked for extremes. Depending on the form of input signal, this may happen some blocks later.

1.2. Hysteresis

The Hysteresis Range defines a condition that the value must pass through for the next value to become valid as the next extreme. If the module recognizes a smaller (mode minima) or a larger (mode maxima) value as the actual hysteresis limit, this value sets the new hysteresis range.

For example:

Hysteresis =	5
series of values:	2, 9, 5, 6, 1, 8, 7, 10, 3

the following values are sent to the output channel:

Minima:	2,1
Maxima:	9,10
Minima and Maxima:	2, 9, 1, 10

The following values are sent to the output channel in the TTL Peak mode:

Minima Function mode:	5, 0, 0, 0, 5, 0, 0, 0, 0
Maxima Function mode:	0, 5, 0, 0, 0, 5, 0, 0, 0
Minima and Maxima:	5, 5, 0, 0, 5, 5, 0, 0, 0

Value 9 is recognized as maximum but the value 5 is not seen as a minimum because the hysteresis condition isn't fulfilled. Instead, 1 is recognized as the next minimum and 8 as the next maximum.

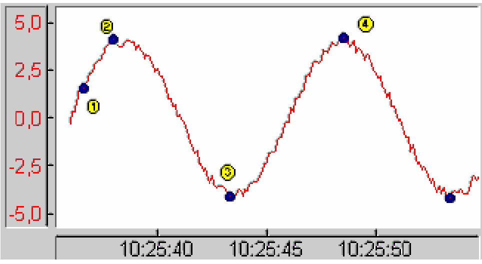
When the Minima or the Maxima mode is chosen, the data value must fall below (the Maximum minus the Hysteresis value) then rise over (the Minimum plus the Hysteresis value) the hysteresis range before the next extreme can be recognized.

1.3. Start Hysteresis

When using the hysteresis range, only values **after** the **first extreme** are recognized. That may cause the identification of some irrelevant extremes.

There are two cases:

1. You are looking for a Minimum; the signal starts with a rising edge.
2. You are looking for a Maximum; the signal starts with a falling edge.



The picture shows the first case. The first output has to be a Minimum. Depending on the Hysteresis condition, we expect the value 3 as the first value output from the Min/Max Module. Measuring errors create a relative Minimum at marker 1, because there is a fulfilled Hysteresis rising edge condition. So the value at the first marker is sent to the output as an incorrect (not relevant) Minimum.

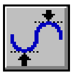
Use a Start Hysteresis to suppress these effects. The value, used as the Start hysteresis, defines a range through which the measured value has to decrease (Minimum) or increase (Maximum) after measurement starts, before the value can be recognized as valid extreme.

The Start Hysteresis is only active until the first extreme is recognized. The value of the Start Hysteresis must be a positive number, and is independent of the direction the signal changes.

1.4. Start Hysteresis and Reset Asynchronous Action

The analysis of the signal restarts when the Min/Max Module is reset, causing the first value to be sent to the module output. The Start Hysteresis is again active until the first extreme is recognized.

2. Statistical Values Module



Use this module to calculate various statistical parameters of the input signal.

Input and Output Characteristics

Number of Inputs: up to 16
Input Block Size: any
Number of Outputs: same as number of inputs
Output Block Size: 1
Max. Number of Modules: any

Operation

Select one of the following statistical parameters to be calculated:

Function	**Output Value**
Maximum	maximum value of the signal
Minimum	minimum value of the signal
Max Position	position (time in seconds, or frequency in Hz.) of the maximum value of the signal
Min Position	position (time in seconds, or frequency in Hz.) of the minimum value of the signal
Mean	arithmetic mean

RMS Value	square mean (**R**oot **M**ean **S**quare)
Variance	$Var = \frac{1}{n}\sum_{i=1}^{n}(x - x_i)^2$, where x is the mean value and n is the block size
Standard Deviation	square root of the variance
Median Weight	Position X_{mg} in a data block, where the sum of the amplitude values on the left is equal to the sum of amplitude values on the right of X_{mg}.

Mode

Two modes are available:

- Running: The specified statistical value will be calculated on the basis of **all** the data acquired by that channel from the beginning of the measurement or the last reset event. With every block of data, the statistical parameter will be updated so that the output always represents the most recent evaluation of all the data that have been sampled.
- Block Based: The output value represents the parameter of the defined number of blocks only. The specified statistical value will be calculated separately for each set of blocks. No earlier data samples or calculated values are taken into account. The output always represents the evaluation of the most recent set of blocks.

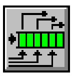
Number of Blocks

Define how many sample blocks will be collected before the specified statistical parameter is calculated. If the number of blocks, *n*, is greater than one, the specified statistical operations will be performed on the basis of groups of *n* input signal blocks. That number of blocks may range from 1 to 8192. A new output value will be generated every *n* blocks.

If the Save number of processed data option is used, the number used to calculate the Maximum, Minimum, or Mean values is stored in a global variable. That function allows you to check the accuracy of the operation in Running mode.

Running values can be reset during an experiment using the Event Driven Actions.

3. Position in Signal Module



Use this block to extract up to 15 single values from the data block according to their position.

Input and Output Characteristics

Number of Inputs: 1, plus up to 15

Input Block Size: same as global block size
Number of Outputs: up to 15
Output Block Size: 1
Max. Number of Modules: any

This module can evaluate one signal channel via one data channel. It can evaluate position information at up to 15 additional inputs.

Use the Channel Bar to determine the number of position values to be extracted from the signal and thus the number of outputs of this module.

With this module up to 15 single values can be extracted at various positions from the incoming data block. Each extracted value can be output via a separate channel.

The module input to which the incoming data block must be applied is marked with an **X**.

Position source specifies the origin of the position information.

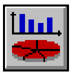
- Initially, the module has only the input channel. The positions to be evaluated for are specified for each channel at Value / Sample no.
- By selecting Inputs, the module is assigned additional inputs. The number of additional inputs depends on the number of positions to be evaluated. The positions are then defined by the applied position inputs.

If values beyond the specified limits are applied to the position inputs these values are decreased/increased to the maximum/minimum limit values.

With the item Interpret value as... you determine how the position specification (i.e., the entry in the value / Sample no. or the value received via the corresponding position input) is interpreted:

- With the Sample no. setting, the n^{th} value in the block is isolated and output.
- With the context sensitive setting the position specification is interpreted for time data as time offset and/or for frequency data as frequency line.
  - For time data, the value in the block will be isolated which corresponds to the elapsed scan time (in seconds) from the start of the data block.
  - For frequency data, the value in the block will be isolated at the incoming frequency line (Hz).

4. Histogram Module



Use this block to calculate the histogram of an input signal.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	the defined number of classes as specified (plus fringe classes, if necessary)
Max. Number of Modules:	any

This module divides the amplitude range up into **n** equal classes, and the number of samples with their amplitude values within each class will be counted.

To define a histogram, you must specify an Interval and the Number of Classes. In addition, you can provide two Fringe Classes for values below and above the range of values to be classified.

The histogram will be calculated for a group of blocks if the number of blocks entered in the dialog box is greater than one.

In addition, the output values can be normalized to a reference value.

To display your histogram, use the Y/t Chart with the Bar line style. To change the line style to Bar, choose the Display menu in the Chart Display window and select Colors and Lines. The Y/t Chart will process histogram data automatically.

The output signals of a histogram module cannot be combined with the output of most other modules, since they are neither time nor frequency related.

Range

Define the range and the classes for the division. Enter the amplitude range here, which will be divided up into classes, and the number of classes. For example:

The interval from **−5.0** to **5.0** is to be divided up into **10** classes.

⇨ The resulting 10 class boundaries will be:

[−5, −4), [−4, −3), ... **[3, 4), [4, 5)**.

The left (lower) boundary value is always assumed to belong to the class; the right (upper) boundary value is already outside that class. In the example above, the first class will contain the values from **−5** (inclusive) to lower than **−4**; the second class will contain the values from **−4** (inclusive) to lower than **−3**, and so forth.

If two additional fringe classes are generated, they will cover all the values below and above the range. In the example above, the lower fringe class will con-

tain all the values between $-\infty$ and **lower than −5;** the upper fringe class will contain all the values between **5** (inclusive) and ∞.

Block Count

To calculate a histogram over a long period, use this option to specify the number of blocks to be grouped in one histogram. The number of blocks may range from **1 to 8192**.

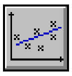
Normalization

The Normalization option allows the scaling of the histogram module's results, so that the results of different measurements can be compared.

- If Normalization is **enabled**, the result can be scaled with respect to the maximum of the histogram or with respect to the total number of counted samples. The histogram will be weighted with a factor so that the maximum or the total sum will be equal to the defined reference value.

  For example: If you want to have the result in a percent scale, set the sum value to 100. The resulting histogram will contain the percentage of samples in the specified classes.
- If Normalization is turned **off**, the result will simply be the number of samples in each class.

5. Regression Module



This module will create an output signal that contains a signal with the linear regression line or with the mean value of the input signal for each block.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The Constant Regression option calculates the mean of an input block and supplies a block of the same length with this constant at the corresponding output.

The Linear Regression option calculates the linear regression line of a block and supplies a signal that represents this line at the corresponding output.

Regression: Order of Regression Polynomial

You can select the order of the polynomial. The maximum is 20.

A polynomial of Order 0, Constant Regression, calculates the average of the values of one block. The result is sent to the output (all values of the output block are the same). The result of the function is always a constant.

The polynomial of Order 1, Linear Regression, calculates the **straight line** that has the **smallest distance** to all measured points (Least Squares Method).

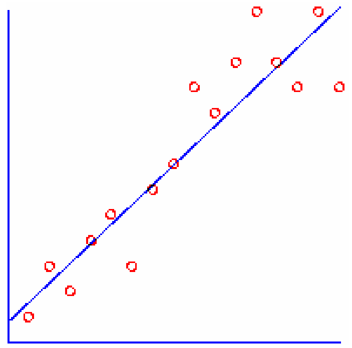
All polynomials of Order 2 and more adapt the calculated course of the signal to the measured points. The higher the order, the better the curve will fit to the real signal. But as the order increases, so does the computation time to make the calculation of the final approximation function and the time to process a block through the module will increase.

A useful application of the module is only possible if the selected size of block is at least **1 larger** than the order of the selected polynomial.

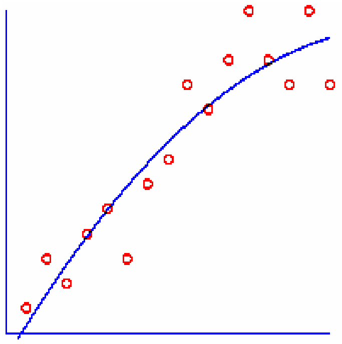
Example:

The following curves are created using the listed values of x/y:

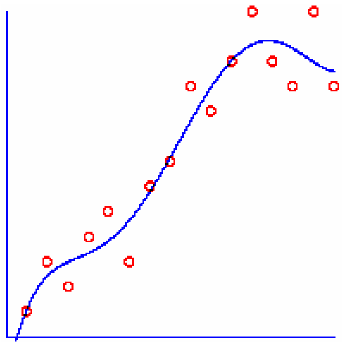
x-values	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
y-values	**1**	**3**	**2**	**4**	**5**	**3**	**6**	**7**	**10**	**9**	**11**	**13**	**11**	**10**	**13**	**10**



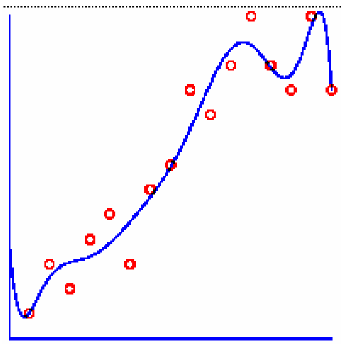
1st Order Polynomial (linear Regression).



2nd Order Polynomial

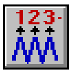


5th Order Polynomial



9th Order Polynomial

6. Counter Module



This module supplies different counting algorithms.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	1 or same as input block size
Max. Number of Modules:	any

This module provides different options for counting events like falling or rising edges, samples, blocks and duration. You can specify whether the result is to be provided at the output as a single value for each block or as a block of the same length as the input signal, representing the current count for each sample.

These events can be counted:

Function		**Output Value**: the current number of...
Blocks	...	blocks
Samples	...	samples
Rising Edges	...	edges from TTL Low to TTL High, i.e., signal changes from < 0.8 to > 2.0
Falling Edges	...	edges from TTL High to TTL Low
Time for Input High	...	seconds since start with level > 1.5
Time for Input Low	...	seconds since start with level ≤ 1.5

Maxima	…	peaks in the signal
Minima	…	negative peaks in the signal
Extrema	…	extremes (minima and maxima) in the signal
Zero Crossing	…	sign changes in the signal
Level Events	…	see below

When this function is chosen, samples will be compared with a defined Level. The type of comparison is shown in window beside this item.

Available Events are:

Level Crossings:	number of samples that crossed the defined level
Signal increase Level:	number of samples that rose above the defined level
Signal decrease Level:	number of samples that fell below the defined level
Signal reaches maximum Level:	number of samples that reached or fell below the defined level
Signal reaches minimum Level:	number of samples that reached or rose above the defined level

In addition, the Count Mode can be set to Running or Block Related in the dialog box.

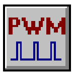
- In Running mode, the count results will be calculated on the basis of **all** the data that have been acquired by the channel since the beginning of the measurement or since the last Reset Action.
- In Block Related mode, only the events in the current block will be counted.

Use Output Mode to specify how the result is to be provided at the output,

- As a Single Value for each block, or
- As a Block of the same length as the input signal, representing the current count for each sample.

☝ *Running values can be reset during an experiment using the Event Driven Actions.*

7. Pulse Width Analysis Module (optional)



This module statistically evaluates pulse-width-modulated (PWM) signals. The value to be computed can be chosen for each channel: frequency (hertz), pulse duration (s), S, pause duration (S) or pulse/pause relationship (%).

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The module can examine the input signal for four different values. All samples initially will output zero until the first measurement is computed. The initial value is held until a new measurement is completed for the defined size.

You can choose from:

Measurement

Frequency**:** Frequency measurement takes place between two rising edges of the input signal, i.e. the output is updated after each rising TTL-edge.

Pulse Duration**:** The Pulse duration is computed after each falling edge.

Pause Duration: The Pause duration is computed after each rising edge.

Pulse-Pause Relationship: The Pulse-Pause relationship is computed after each edge.

Calculation Borders

A restriction can be defined n which time period an edge must appear. If **no edge appears** at the input in the time specified, the **signal** is assumed to be constant.

In this case, the Frequency and the Pulse-Pause relationship are **zero**.

For pulse-duration and pause-duration:

If the input has a TTL-High signal, then the value is continuously increased for the pulse-duration (and is not held), the pause duration value is zero.

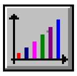
If the input has a TTL-Low signal, the value is increased continuously for the pause-duration (and is not held); the pulse duration value is zero.

The time interval can amount also to several days, you can choose from seconds, minutes, hours or days.

Set the sampling rate so that the smallest pulse (as well as the smallest pause) to be measured contains as many samples as needed for the required resolution. The sample rate has to be at least twice as big is as the largest frequency

that you expect to measure.

8. Sort Channels (optional)



*This Module **sorts** the **values** of several **channels** in **increasing** or **decreasing** order. .*

Input and Output Characteristics

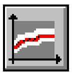
Number of Inputs:	2, up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The Module analyses the values at the inputs and sorts them to the output channels.

Sort mode:

Ascending:	value at output 0 is the lowest value
Descending:	value at output 0 is the highest value.

9. Check Reference Curve Module



This Module is able to compare an incoming data stream with a previously stored Reference curve. The module processes up to 16 separate channels with assigned Reference curves. Each input channel gets an output channel, which outputs the result of comparison.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

9.1. Settings

In the Reference curve file, the active reference curve for the active channel is shown. If there is no file selected (Entry: DEFAULT.DSK), use the File... button to open the file menu to select the desired file (*.DSK).

If there is no existing Reference curve file, you first have to create it using the Reference Curve module in a test run of your experiment.

The Tolerance band option modifies the way the tolerance bands is created, based on the data stored in the set point file. The following options are available:

- Use upper tolerance band
- Use lower Tolerance band

You can select the way that the data is compared with the Reference curve:

- Min/Max: If the actual value exceeds the maximum curve or under runs the minimum curve the preset Output values are sent to the output channel.
- Reference curve ± x %: If the actual value deviates by the defined percentage, the preset Output values are sent to the output channel.
- Reference curve ± (constant + x %): If the actual value deviates by the defined percentage ± a constant, the preset Output values are sent to the output channel.
- Reference curve ± constant: If the actual value deviates by the defined constant value, the preset Output values are sent to the output channel.
- Reference curve ± (n * Standard Deviation): if the deviation of the actual value is greater than n * Standard Deviation, calculated with the values of the Reference curve, the preset Output values are sent to the output channel.

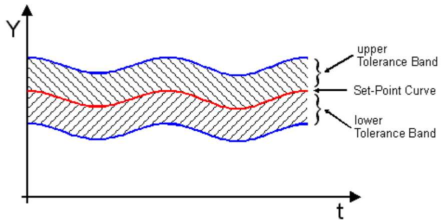
The constant used in some of the options above has to be defined in the entry field Constant.

The output settings define the values that are sent to the output channels if the defined limits are obeyed, exceeded or under run.

9.2. Tolerance Band

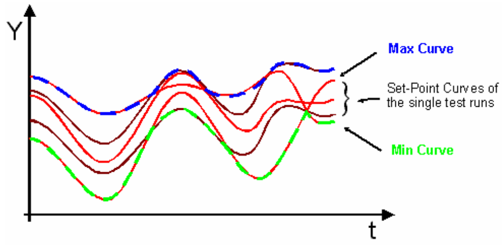
The following Chart explains the tolerance band item.

All values between the limits of the tolerance bands are accepted. Other values modify the values at the output channels, depending on the output settings.



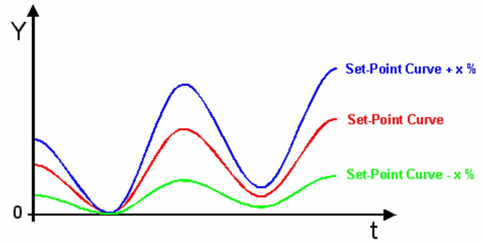
9.3. Min/Max Curve

The following Chart shows how the Min and Max curves calculated by the Reference Curve module are used as upper and lower tolerance limits.



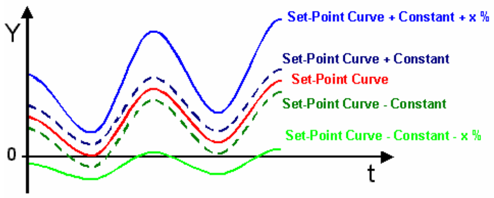
9.4. Reference curve ± %

This kind of evaluation adds or subtracts xx Percent of the Reference value to the Reference value to get the upper and lower limit.



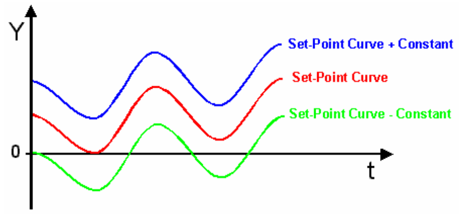
9.5. Reference curve ± (Constant + %)

This kind of evaluation adds or subtracts xx Percent of the Reference value and a predefined Constant to the Reference value to get the upper and lower limit.



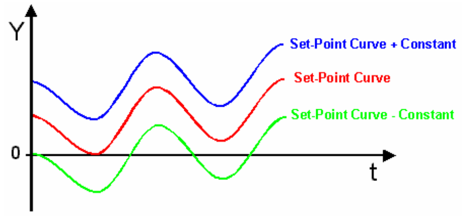
9.6. Explanation Reference Curve ± Constant

This kind of evaluation adds or subtracts a predefined Constant to the Reference value to get the upper and lower limit.



9.7. Reference Curve ± n * Standard Deviation

This kind of evaluation adds or subtracts a multiple of the Standard Deviation, calculated with all test runs of the experiment, to the Reference value to get the upper and lower limit.



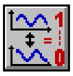
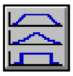
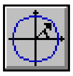
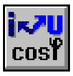
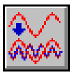
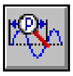
Standard Deviation is calculated as follows:

$$\sigma = \sqrt{\frac{1}{n}\sum_{i=n}^{n}(x - x_i)^2}$$

Chapter 7
Signal Analysis

Chapter 7: Signal Analysis Module

This group consists of modules performing frequency analysis.

	Module	Basic version	optional
	**Filter**		x
	**Correlation**		x
	**Data Window**		x
	**FFT**		x
	**Polar/Cartesian Coordi-nates**		x
	**Electric Characteristics**		x
	**Harmonic Distortion**		x
	**Period Check**		x

1. Filter Module (optional)

This module provides digital signal filtering with infinite impulse response filters.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The filters in ***ServiceLab*** are stable IIR filters with very steep slopes. These filters are used to cut off certain frequency components from the time signal. They are easy to implement and to use, but their disadvantage, compared to analog filters, is that they cannot be used as anti-aliasing filters. Any anti-aliasing filters must be applied before A/D conversion.

ServiceLab provides several digital filters of different type, characteristics, order and quality with adjustable cut-off frequency.

- The Filter Type determines the transfer function of the filter. You can choose between Lowpass and Highpass filters. Using a combination of lowpass and highpass filters, you can create Bandpass and Bandstop filters. Additionally, you can switch off filtering without removing the module (no operation).
- The Filter Characteristics that can be selected are Bessel, Butterworth and Chebyshev with different ripples.

Filter Characteristics

- Bessel filters are characterized by a small overshooting in their step response, and very low steepness.
- Butterworth filters are maximally flat, with an extremely small passband ripple and medium steepness. They show a strong overshooting in their step response, and their transfer function in the passband is nearly constant.
- Chebyshev filters have a defined passband ripple. Compared to the other types they have the greatest steepness. The ripple in the passband can be set to either **0.5 dB** or **2 dB**.

Filter Types

- Lowpass filters are important in many signal analysis applications. They **cut off** or damp high frequencies, while lower frequencies can pass the filter nearly unchanged.

⇨ *Digital lowpass filters cannot be substituted for analog anti-aliasing filters because aliasing is an effect of the digitalization and not of the subsequent analysis.*

- Highpass filters are the inverse of lowpass filters. They damp low frequencies and allow frequencies above the defined cut-off frequency to pass through unchanged.
- Off: This switch turns digital filtering off without removing the filter module from the worksheet (no operation).

Cut-off Frequency

For all the filter types, the Cut-off Frequency defines the frequency at which the damping of the filter is exactly **3 dB**. Damping beyond this frequency is dependent on the filter type and the defined order of the filter. The frequencies that can be used depend on the global sampling rate. Only frequency values within the following range can be set:

$$\mathbf{0.001\ F_N < f_g < 0.9\ F_N}.$$

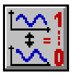
$\mathbf{F_N}$ is the Nyquist frequency (the sampling rate divided by two) and $\mathbf{f_g}$ is the defined cut-off frequency. To avoid stability problems during calculation and application of the filters, ***ServiceLab*** allows a frequency range that is smaller than theoretically possible. If values outside this range are entered, ***ServiceLab*** will prompt with a message and turn off the filters completely. The measurement will not be interrupted.

Filter Order

The filter order defines the number of poles of the filter. Increasing the number of poles increases the steepness, but at the same time increases the phase shift.

The maximum order for lowpass and highpass filters is **10**.

2. Correlation Module (optional)



This module performs the calculation of correlation functions and coefficients and the application of the power cepstrum.

Since this module provides different basic operations**,** you must first select the function type when you install the module.

This module provides **two** function types:

- Correlation Coefficient and Cross Correlation
- Auto correlation and Cepstrum

Once this module is integrated into the worksheet, its module configuration dialog box will provide only the settings and options for the selected type. If you wish to use another type, delete the module first, and install it again, choosing the new type.

Because this module performs several basic operations, the selection of the module type determines the number and function of the module entries.

2.1. Correlation Coefficient and Cross correlation

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	any; the block sizes of pair members must be identical
Number of Outputs:	same as number of inputs
Output Block Size:	1, or same as input block size
Max. Number of Modules:	any

In the module configuration dialog box you can choose which of the two functions to apply to the signal of the selected channel.

- The Correlation Coefficient of the input signal pair is a single value for each block, between –1 and 1.
  - Values near 1 represent a good correlation; the input signals are of similar shape.
  - Values near 0 mean that there is no correlation.
  - Values near –1 represent a good anti-correlation.
- The result of Cross Correlation is a full block for each signal input block. Each one represents the correlation function. The first value is equal to the correlation coefficient; the other values are the correlation coefficients for the periodically shifted signals. The time shift is used as the abscissa of the correlation function.

2.1.1 Definition: Correlation

The (discrete) correlation coefficient over (a block of) two signals X and Y is defined as:

$$\mathrm{Corr}(X,Y) = \frac{\sum_i (X_{(i)} - X_x) * (Y_{(i)} - Y_y)}{\sqrt{\sum_i (X_{(i)} - X_x)^2 * \sum_i (Y_{(i)} - X_y)^2}}$$

with

the sum over index i from 0 to block size -1

X[i] = value of first signal at position i

Xx = sum(X[i])/block size = mean value of first signal

Y[i] = value of second signal at position i

Xy = sum(Y[i])/block size = mean value of second signal

The correlation coefficient measures "how similar two signals are", i.e. Corr(X,X) = 1, Corr(X,-X) = -1, and Corr(X,Y) = 0 if the signals are "completely different". It is always in the range of -1 .. 1.

2.1.2 Definition: Crosscorrelation

The cross correlation of two signals is a series of correlation coefficients and is defined as:

Cross[0] := Corr(X,Y)

Cross[1] := Corr(X,YR1)

...

Cross[j] := Corr(X,YRj)

where

YRj is the signal Y rotated in the block by j positions i.e. YRj[i] = Y[(i+j) modulo block size]

The Autocorrelation of a signal is defined as the cross correlation with itself. This implies AutoCorr[0] = 1 for any signal.

2.2. Auto Correlation and Cepstrum

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any; the block sizes of pair members must be identical
Number of Outputs:	same as the number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module performs the calculation of correlation functions and coefficients as well as the application of the power cepstrum.

Since this module provides different basic operations, you must first select the function type when you install the module.

This module provides **two** function types:

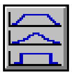
- Autocorrelation is the cross correlation of an input signal with itself; the same signal is used for both inputs.

  With the Autocorrelation function it is possible to detect an inherent periodicity in the signal itself. High values represent a similarity of the signal with its shifted copy. The Autocorrelation function is scaled so that its first value is 1.

  It is calculated as the inverse Fourier transform of the signal's power spectrum.

- The Cepstrum function is used to detect echoes or multiplicative superpositions in the signal, especially in speech analysis. The Cepstrum function is scaled so that its first value is 1. It is calculated as the inverse Fourier transform of the signal's logarithmic power spectrum.

3. Data Window Module (optional)



This module prepares data for further analysis, especially by an FFT module.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as the defined vector size
Max. Number of Modules:	any

This module prepares data for further analysis:

- It changes the block size so that an FFT module can be provided with appropriate block sizes (powers of two).

  The Windowing module represents a buffer that can store blocks or parts of blocks. The output block size is independent of the input block size and equal to the defined vector size.
- It can weight the incoming blocks with different window functions. The effect of discontinuities at the edges of the analysis interval on the FFT result will be diminished by this weighting (leakage effect).
- ***ServiceLab*** provides a number of different window vectors. Each of them is characterized by certain advantages and disadvantage. There is no ideal general-purpose window, and we can only give some rough hints concerning their characteristics and suitability in the list of Window Types (see page 7-7).

  Generally speaking, a window vector damps the side lobes of singular spectral lines, which is a desired effect, but it also widens the main lobe, which is an unwelcome effect, since it reduces the spectral resolution and the dynamics of the spectrum.
- Some of the window types need an additional parameter for definition. This value is dependent on the window type itself. You will find further details in the comprehensive table of Window Specifications (see page 7-9).
- You can also activate Amplitude Correction.
- In the Overlap Adjustment box you can specify the overlap for a FFT. If the overlap is greater than 0, the defined number of samples will be in-

cluded in the next block. This causes the module to release more data at its output channels than it receives at its input channels. Overlap is entered in samples.

The windowing is performed after overlapping. A reasonable value for the overlap is the block size divided by two. However, the decision as to which is the best value depends on the window function that is used.

3.1. Window Types

The following Window Types are provided by ***ServiceLab***:

- **Rectangle**
- **Bartlet (Triangle)**
- **Hamming**
- **Hanning**
- **Power of Cosine**
- **Blackman**
- **Blackman-Harris**
- **Tukey**
- **Poisson**
- **Hanning-Poisson**
- **Cauchy**
- **Gauss**
- **Flat top**

Rectangle Window

This window type does not change the signal at all. Use it if you are only using this module to change the block size of your signal.

Bartlet Window

This window type weights the signal block with a triangle function, which is a piecewise linear function that is 0 at both ends of the block and 1 in the middle.

Hamming Window

This window type weights the signal block with a Hamming function. It may be regarded as a modified Hanning window. It is implemented as a cosine function with an offset of 0.08. It does not remove the discontinuities completely.

Hanning Window

This window type weights the signal block with a Hanning function, which is a cosine square wave. This window corresponds to the Power of Cosine window with the parameter 2. It is one of the more frequently used windows with a well-balanced effect on the damping of the side lobes and the widening of the main lobe.

Power of Cosine Window

This is a generalization of the Hanning window. To define it completely, the exponent must be specified. Frequently used values for the exponent are 1, 2, 3, and 4. Increasing the exponent results in a weighting vector that decreases faster at

the boundaries. The damping of the side lobes will be better, but the main lobe will be wider; so the frequency resolution of the spectrum may be lower.

Blackman Window

The Blackman window is a corrected Hamming window with an additional cosine term. It damps the side lobes better than the Hamming window.

Blackman-Harris Window

This is a refined modification of the Blackman window with cosine terms up to the fourth order. In general, its effects are more balanced than those of the Blackman window, but it is more complex to calculate.

Tukey Window

The Tukey window is a combination of the Rectangle and the Power of Cosine windows. It does not influence the amplitude of the time signal in the middle of the transfer block, so the main part of the signal energy and of the information in the signal is preserved.

The necessary parameter may vary between 0 and 1. It defines the size of the constant part of the window vector. A parameter equal to 0 yields the cosine window, while a parameter equal to 1 results in a rectangle window.

Poisson Window

The defining function of the Poisson window is a two-sided exponential:

❍ $w(n) = e^{-\alpha |n| / \frac{N}{2}}$ $|\mathbf{n}| \leq \mathbf{N/2}$.

The parameter (α) determines the damping at the boundaries of the analysis interval. Reasonable values for α are between 1 and 10.

Hanning-Poisson Window

The defining function of the Hanning-Poisson window is the product of the two functions of Hanning and Poisson. Reasonable values for the parameter (α) are between 1 and 10.

Cauchy Window

The Cauchy window, which is not used very often, is calculated according to the formula:

❍ $w(n) = \dfrac{1}{1+\alpha(\frac{2n}{N})^2}$ $|\mathbf{n}| \leq \mathbf{N/2}$.

Gauss Window

The basis of the Gauss window is the Gauss normal distribution function:

❍ $w(n) = e^{-2\,(\alpha\, n/N)^2}$ $|\mathbf{n}| \leq \mathbf{N/2}$.

Reasonable values for the parameter (the deviation value α) are between 0 and 10.

Flattop Window

This kind of window is useful for calibrating data because it causes only small divergences in amplitudes.

In most cases the user will prefer the Hanning Window, because its bandwidth is smaller (factor 2.5).

The Flattop Window is calculated as follows:

$\omega(t) = 0.2395 - 0.4581*\cos(2*\pi*t/T) + 0.2585*\cos(4*\pi*t/T) - 0.0439*\cos(6*\pi*t/T)$ if $0 \le t < T$

otherwise $\omega(t) = 0$

3.2. Window Specifications

The following table lists some of the values characterizing the different window types.

Some of these window types need an additional parameter for definition. Its value depends on the window type itself.

Window Function	Para-meter	Side Lobe Level (dB)	Side Lobe Slope (dB/Oct)	3 dB Width of Main Lobe (multiples of resolution)	Amplitude Damping
Rectangle	––	–13	– 6	0.89	1.00
Bartlett (Triangle)	––	–27	–12	1.28	0.50
Hamming	––	–43	– 6	1.30	0.54
Hanning	––	–32	–18	1.44	0.50
Power of Cosine	1.00	–23	–12	1.20	0.64
	2.00	–32	–18	1.44	0.50
	3.00	–39	–24	1.66	0.42
	4.00	–47	–30	1.86	0.38
Blackman	––	–58	–18	1.68	0.42
Blackman–Harris	––	–92	– 6	1.90	0.36
Tukey	0.25	–14	–18	1.01	0.88
	0.50	–15	–18	1.15	0.75
	0.75	–19	–18	1.31	0.63

Window Function	Parameter	Side Lobe Level (dB)	Side Lobe Slope (dB/Oct)	3 dB Width of Main Lobe (multiples of resolution)	Amplitude Damping
Poisson	2.00	–19	– 6	1.21	0.44
	3.00	–24	– 6	1.45	0.32
	4.00	–31	– 6	1.75	0.25
Hanning–Poisson	0.50	–35	–18	1.54	0.43
	1.00	–39	–18	1.64	0.38
	2.00	–––	–18	1.87	0.29
Cauchy	3.00	–31	– 6	1.34	0.42
	4.00	–35	– 6	1.50	0.33
	5.00	–30	– 6	1.68	0.28
Gauss	2.50	–42	– 6	1.33	0.51
	3.00	–55	– 6	1.55	0.43
	3.50	–69	– 6	1.65	0.37
Flattop	--	-70	– 2	3.38	0.24

3.3. Vector Size

The Windowing module can process signals of any input block size. The output block size will always be the defined vector size. Since this module is generally used in combination with the FFT module, which needs a power of two block size, these values are predefined. The vector size may vary between 16 and 32,768.

⇨ *Any other vector size can be used when the power of two value is not needed, but you cannot perform a FFT with these blocks.*

3.4. Amplitude Correction

Since every weighting function except the rectangle has an integral less than one, its application causes lowering of the signal's energy by a factor that equals its integral. If Amplitude Correction is switched on, this effect will be compensated for by a multiplication of the spectrum with the same factor.

4. Fast Fourier Transform Module (optional)

This module provides different algorithms for spectral analysis.

Since this module provides different basic operations, you must first select the function type when you install the module.

This module provides **four** function types:

- Real FFT of a Real Signal
- Complex FFT of a Real Signal
- Complex FFT of a Complex Signal
- Cross Spectrum of Two Real Signals

Once the module is integrated into the worksheet, the module configuration dialog box will provide only the settings and options for the selected type. If you wish to use another type, delete the module first, and install it again then choosing the new type.

Since this module provides several basic operations, the selection of the function type also determines the number and function of the module entries. For the Real FFT of a Real Signal type, a maximum of 16 module entries is available; a maximum of 8 entries is available for type Complex FFT of a Real Signal. Types Complex FFT of a Complex Signal and Cross Spectrum of Two Real Signals allow up to 8 pairs of module entries.

Filter

You can integrate, double integrate, differentiate or double differentiate the input data of the FFT module, before the FFT is performed. This allows you to investigate the acceleration or speed data of the signal. The built-in integration function avoids the problems of the integration constant, which you must consider if you use the Integration/Differentiation module.

⇨ *The Fourier transform, as well as the algorithms based on it, are very powerful but complex tools used for signal analysis. The easy-to-use implementation in **ServiceLab** does not completely eliminate erroneous results. Please read the following general remarks regarding the FFT for further information.*

4.1. FFT: General Remarks

The **Fourier Analysis** is based on Fourier's theorem that every periodic signal can be decomposed in a series of harmonic functions. The methods implemented in this module allow the calculation and analysis of these frequency components.

The following essential conditions should be taken into account when FFT operations are to be performed:

- **Frequency Components** in the signal and **Sampling Rate**

This is a condition for every digitalization. The sampling rate must be at least twice as high as the highest frequency component in the analog signal (Shannon's theorem). Since this is a theoretical limitation for most applications, it is better to have a larger over sampling. In general, an over sampling of 5 to 10 is sufficient; otherwise amplitude errors may occur due to the digitalization, though the frequency detection may be correct.

- **Limited Analysis Intervals**

  Every digital signal analysis method can only deal with a limited section of the time signal. The signal outside this section is always assumed to be a periodic continuation of that section. The length **T** of the analysis interval determines the basic frequency:

  - $$f_b = \frac{1}{T}.$$

  If, as is generally the case, the time signal contains frequencies which are not an integer multiple of that frequency, these frequencies will not be identified as sharp spectral lines but be smeared to several lines. This is called the **leakage effect**. A well-suited window vector can reduce this effect. One undesirable side effect may be the widening of the main lobe.

4.2. Real FFT of a Real Signal

This function calculates and analyzes the discrete spectrum of a signal.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	must be a power of two
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size, or half of the input block size
Max. Number of Modules:	any

This FFT function type provides several FFT based Operations. If necessary, the spectrum may be transformed into a dB Scale.

Choose the Suppress DC Component option to inhibit all DC components in signal.

The following FFT operations are available:

- Fourier Spectrum: The result is the two-sided amplitude spectrum of the signal. The output block size is the same as the input block size.
- Amplitude Spectrum: The result is the one-sided amplitude spectrum. In contrast to the Fourier Spectrum, each frequency component except the DC part is twice as large due to the summation of the symmetric frequencies. The output block size is half of the input block size.

- Power Spectrum: The power spectrum is the square of the Fourier Spectrum, but only one-sided. The output block length is half the input block length.
- Power Density Spectrum: The Power Density Spectrum differs from the Power Spectrum by a factor **b** which represents the frequency resolution:

  $b = \frac{1}{f_b}$.
- Phase Spectrum: The result is the phase spectrum of the input signal.

  The output block size is the same as the input block size. The output signal is normalized to 0 to 360º.
- dB Transform: If dB Transform is switched on, the resulting spectrum will be logarithmically transformed: $y = 20 * \log\left(\frac{x}{b}\right)$, where **x** is the input signal and **b** is one of the following reference values:
  - Definable Reference Value
  - Maximum of the First Block
  - Maximum of All Recent Blocks
  - Maximum of the Current Block.

Choose the Suppress DC Component option to inhibit all DC components in signal.

⇨ *dB scales can only be compared if the reference value is the same for all the spectra. This is generally the case for a defined reference value and for the maximum of the first block, but not for the others.*

4.3. Complex FFT of a Real Signal

This function calculates and analyzes the discrete spectrum of a signal.

Input and Output Characteristics

Number of Inputs:	up to 8
Input Block Size:	must be a power of two
Number of Outputs:	up to 16
Output Block Size:	same as input block size
Max. Number of Modules:	any

This FFT provides two outputs for each input. The output signal contains the real component and the imaginary part of the FFT of the real signal.

You can choose the complex conjugate of the output signal, which means that for each input the imaginary part of the result will be multiplied by -1.

Choose the Suppress DC Component option to inhibit all DC components in signal.

Up to 8 module entries and 16 outputs can be activated. The input block size must be a power of two; the output block size is the same as the input block size.

4.4. Complex FFT of a Complex Signal

This function calculates and analyzes the discrete spectrum of a signal.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	must be a power of two
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This FFT type provides two inputs and two outputs for each function. You can choose between Fourier Analysis and Fourier Synthesis.

You can also choose the complex conjugate of the output signal, which means that for each input the imaginary part of the result will be multiplied by –1.

Up to 8 functions can be performed simultaneously in each module. The input block size must be a power of two at both entries; the output block size at the outputs is the same as the input block size.

The real component has to be connected to **input 1** of each signal pair, the **imaginary component** to **input 2**. **Output 1** contains the **real component** of the processed signal pair, **output 2,** the **imaginary component**.

4.5. Cross Spectrum of Two Real Signals

This function calculates and analyzes the discrete spectrum of a signal.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	must be a power of two
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

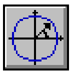
This FFT type provides two inputs and two outputs for each function. It calculates the cross spectrum of the two input signals. This means that the complex spectra are calculated for both input signals, and the first spectrum is multiplied with the complex conjugate of the second.

Choose the Suppress DC Component option to inhibit all DC components in the signal.

Up to 8 functions can be performed simultaneously in each module. The input block size must be a power of two at both entries; the output block size at the outputs is the same as the input block size.

Output 1 contains the **real component** of the processed signal pair, **output 2,** the **imaginary component**.

5. Polar/Cartesian Coordinates Module (optional)



This module converts a pair of input signal values defining a curve in Cartesian coordinates into polar coordinates and vice versa.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

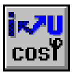
Either of the following operations can be selected for each pair of module entries:

Cartesian ⇨ Polar - conversion from Cartesian to polar coordinates.

Polar ⇨ Cartesian - conversion from polar to Cartesian coordinates.

The first member of each input or output pair defines the real part or the amplitude respectively; the second member defines the imaginary part or the angle. Angles can be entered in degree (from -180 to $+180$) or radian values (from $-\pi$ to $+\pi$).

6. Electric Characteristics Module (optional)



*The **Electric Characteristics** Module **computes the well-known electrical engineering quantities** based on **voltage U** and **current I**, including **power**, **phase angle**, as well as the input frequencies.*

Input and Output Characteristics

Number of Inputs:	2, 3, or 4 based on chosen function
Input Block Size:	any, but U and I with the same block size
Number of Outputs:	16
Output Block Size:	1
Max. Number of Modules:	any

The 16 outputs of the module correspond to the 2 ... 4 inputs with the listed conditions.

6.1. Inputs

U Data input voltage: Sampling value index, i(k) sample value on index k

I Current: Sampling value index, i(k) sample value on index k

C Control input for calculation: This input is only available if the Trigger on Rising Edge At Control Input condition is selected as the Calculation option

R Control input for Delete: This input is only available if the Trigger on Rising Edge At Control Input condition is selected as the Delete option

6.2. Outputs

Channel 0 Sampling value index

Channel 1 Effective Voltage -> Effective value = sqrt(1/N * Sum {k=1..N} (x2(k))), x=U

Channel 2 Effective Current -> Effective value = sqrt(1/N * Sum {k=1..N} (x2(k))), x=I

Channel 3 Active Power = 1/N * Sum {k=1..N} (u(k) *i(k))

Channel 4 Apparent Power = U_{eff} * I_{eff}

Channel 5 Reactive Power = U_{eff} * I_{eff} * sin(Phi)

Channel 6 Phase Angle Phi = arccos(Pw/U_{eff}/I_{eff})

The Angle in Degrees setting interprets the incoming values in degrees (0-360); the Angle in Radians setting interprets them in radian measure (rad) (0-2 PI). You can also show the sign to detect whether the current is trailing (- sign) or leading (+ sign). *Attention:* To detect the sign only the first two zero crossings of current and voltage are used (each time the measurement starts).

You can perform additional sign detection during the running measurement. Use an event driven action or delete the calculated characteristics to initiate the new sign detection (see also dialog delete). In the working mode Calculate For Each Single Block *(Reset after each block)* on each new data block the sign is calculated again.

Channel 7 cos Phi

Channel 8 sin Phi

Channel 9 Input frequency in the data input Voltage

The input frequency is calculated as follows:

F = (n-1) / (t2-t1)

n : Number of positive zero crossings

t1 : time from start to the first positive zero crossing

t2 : time from start to the last positive zero crossing

If there is a zero crossing between two measured values (p = predecessor, s = successor) the assignment of the time stamp t to

the zero crossing happens as described in the following 4 cases (--- shows the zero line).

```
a) ---p---s--- t = tp

b) -------s--- t = ts
      p

        s
c) ---p------- t = tp

        s
d) ----------- t = (ts+tp) / 2
      p
```

Channel 10 Number of positive Zero Crossings in the data input Voltage

At the horizon of the defined zero line (you can use a global variable but it is only read once at measurement start and is not updated while the measurement is running) all zero crossings (predecessors beneath or on the zero line, successors over or on the zero line) following the defined hysteresis (also definable as global variable read once at the measurement start) are calculated. Hysteresis is used to reduce statistical errors but also to filter small amplitudes that often result from noise and random interferences of the measurement equipment The hysteresis effects that the next detection of a zero crossing event is only started if the oscillation left a defined band around the zero line (value < zero line – Hysteresis/2 or value > zero line + Hysteresis/2).

Channel 11 rejected positive Zero Crossings of Voltage

Depending on the information of the channels 10 and 11 or 13 and 14 you can select a useful hysteresis for the input signal, if frequencies are known.

Channel 12 Input frequency in the data input Current

Channel 13 Number of positive Zero Crossings in the data input Current E

Channel 14 rejected positive Zero Crossings of

Channel 15 Error messages

0 = no error detected
1 = the signs of the results in channel 6 and 8 are not unambiguously defined (The sign is only unambiguous if the phase angle Phi is in the interval –180° > Phi < +180°)
2 = the input frequencies of voltage and current vary more than +/- 0.1 Hz
3 = the interval that the data block covers is smaller than a complete periodic oscillation of voltage and current.
4 = No values to calculate (previous Reset).

6.3. Options

Calculation

- Calculate For Each Single Block *(Reset after each block:* The calculation is performed for each block. Each result is sent to the output. After each output the characteristic values are deleted for new calculation.
- Calculate In Running Mode With All Received Blocks: The calculation is performed in running mode and the result is sent to the outputs as each block is processed. The index k is counted over all received blocks. You can reset the characteristic values depending on the setting in the *Delete list box* (also reset the Index k).
- Calculate If Rising Edge At The "C" Control Input: The calculation of the characteristic values is performed in running mode. The index k is counted over all received blocks. If the input ***C*** detects a rising edge crossing the value 2.5, the actual calculated characteristic values are sent once to the output. You can reset the characteristic values depending on the setting in the *Delete list box* (also reset the Index k).
- Calculate On Asynchronous Event Driven Action: The calculation of the characteristic values is performed in running mode. The index k is counted over all received blocks. If a user defined condition is detected using the Action module, the actual calculated characteristic values are sent once to the output. You can reset the characteristic values depending on the setting in the *Delete list box* (also reset the Index k).

Delete

- Disabled: Deletion of the calculated values is disabled.
- Delete If Rising Edge At The "R" Control Input : If the input ***R*** detects a rising edge crossing the value 2.5 the calculated characteristic values are **deleted once**. The actual values at the ***U*** and ***I*** inputs are used for the next calculation step but not are used in the running calculation.
- Delete On Asynchronous Event Driven Action: If a user defined condition is detected the calculated characteristic values are **deleted once**. The actual values at the ***U*** and ***I*** inputs are used for the next calculation step but not are used in the running calculation.

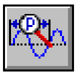
6.4. Error Messages

The following messages can be shown if the data at the inputs ***U*** and ***I*** are not correct:

Time information or block length of the data streams are different. You cannot link these channels. STOP!

Illegal block size. STOP!

7. Harmonic Distortion Module (optional)



*The module **calculates** the **Amplitude** and **Phase of the fundamental wave** in the defined frequency interval and calculates **up to 48 harmonic waves** (they can be out of the defined interval) with the corresponding Amplitudes and Phases. Please read the hints below for correct usage of the Harmonic Distortion Module.*

Input and Output Characteristics

Number of Inputs:	2, 3, or 4 based on chosen function
Input Block Size:	any, but F and P with the same block size
Number of Outputs:	9
Output Block Size:	1
Max. Number of Modules:	channel 1, 2, 3, 4: depends on the configuration (24, 25, 49) of channel 0, 5, 6, 7, 8: 1

Each of 9 outputs of module corresponding to a calculation based on the inputs.

7.1. Inputs

F Data input: Amplitude Spectrum: Use the Real FFT of a Real Signal module to prepare the input signal

P Data input Phase Spectrum: Use the Real FFT of a Real Signal module to prepare the input signal

C Control Input for calculation: The input is only available if the Calculate If Rising Edge at the Control Input mode is selected in Calculation list box.

R Control input to delete: The input is only available if the Calculate If Rising Edge at the Control Input mode is selected in Delete list box.

7.2. Outputs

Channel 0 Number of Fourier spectra, as basis for calculation

The All, Even or Odd setting changes the output:

- For channel 1-> *49* (fundamental wave + 48 harmonic waves), *24* (fundamental wave + 23 harmonic waves) or *25* (fundamental wave + 24 harmonic waves) counted identifier,
- At channel 2, the corresponding frequencies, at channel 3 the corresponding amplitudes

  And
- At channel 4, the corresponding phases.

Fundamental wave and harmonic waves are calculated as follows:

The maximum amplitude is selected in the defined Frequency Interval (Frequency from ... to). The corresponding frequency is defined as fundamental wave.

The algorithm search for the x^{th} harmonic wave using integer multiples of the frequency in a small frequency interval around the named position. The maximum found in the interval is used as x^{th} harmonic wave (with the corresponding position in frequency band). The found frequency does not have to be an exact integer multiple of the fundamental wave.

Channel 1 x^{th} Harmonic Wave

Channel 2 Frequency of the v Harmonic Wave

Channel 3 Effective value of x^{th} Harmonic Wave

Channel 4 Phase Shift of the x^{th} Harmonic Wave

Channel 5 Relative Harmonic Content

The Relative Harmonic Content is calculated as:

$$\sqrt{\frac{1}{1+\frac{A^2_{fundamental}}{\sum_{i=1}^{N} a^2_{harmonic(i)}}}}$$

Channel 6 Total Harmonic Content

Total Harmonic Content is calculated as shown:

Type 1: **Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.**

Type 2: **Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.**

Type 3: $U_{THD} = \frac{\sqrt{\sum^{N} U^2}}{U_1}$

Channel 7 Harmonic Distortion Factor

The Harmonic Distortion Factor is calculated as shown:

Type 1: **Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.**

Type 2: **Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.**

Type 3: **Fehler! Es ist nicht möglich, durch die Bearbeitung von Feldfunktionen Objekte zu erstellen.**

Channel 8 Error Messages

0 = no error detected
4 = no data at the input received (earlier Reset).

7.3. Options

Calculation:

- Calculate Each Single Spectrum: The characteristic values are calculated and output separately for each spectrum. After each calculation the values are deleted.
- Calculate with All Spectra in Average Mode: The specified number of spectra is collected and averaged, and then the characteristic values of the averaged spectrum are calculated and output. The values are then deleted depending on the setting in the Delete List box.
- Calculate On Edge Low to High at The Control Input: All spectra are collected. If a rising edge (crossing 2.5) is detected at the input ***C,*** the collected spectra are averaged, the characteristics calculated and sent to the output. The values then will be deleted depending on the setting in the Delete List box.
- Calculate On Asynchronous Event Driven Action: All spectra are collected. If the Action module detects the defined condition, the collected spectra are averaged and the characteristic values are calculated and sent once to the output. The values then will be deleted depending on the setting in the Delete List box.

Delete:

- Disabled
  Deletion of the calculated values is disabled.
- Delete If Rising Edge Is at the Control Input : If a rising edge (crossing 2.5) is detected at the input ***R***, the calculated characteristic values are **deleted once**. The actual values at the inputs ***F*** and ***P*** are used for the next calculation step but are not are used in the running calculation.
- Delete on Asynchronous Event Driven Action: If the Action module detects the defined condition, the calculated characteristics are **deleted once**. The actual values at the inputs ***F*** and ***P*** are used for the next calculation step but not are used in the running calculation.

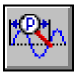
7.4. Error Messages

The following messages can be shown if the data at the inputs ***F*** and ***P*** are not correct:

Time information or block length of the data streams are different. You cannot link these channels. STOP!

Illegal block size. STOP!

8. Period Check Module (optional)



*The **Period Check** module **checks the data** for **the first positive zero crossing** at a specified zero line (you can use global Variables).*

After the positive zero crossing is detected, data samples are collected until the preset number of output blocks is reached. At that time, the data is sent to the outputs of the module for further processing. The cycle then starts again for the next positive zero crossing.

Thus, the signal of each output block starts with a positive zero crossing that is needed to process a continuous calculation of phase spectra. There will be a small loss of data between input and output.

Input and Output Characteristics

Number of Inputs:	Up to 16
Input Block Size:	any
Number of Outputs:	Up to 16
Output Block Size:	1
Max. Number of Modules:	any

8.1. Inputs

0 (I)...15* Data Input **with** Time signal

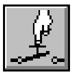
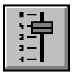
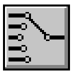
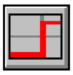
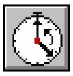
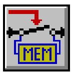
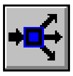
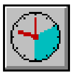
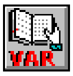
8.2. Outputs

0(O)...15 Data Output **with** Time signal

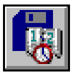
Chapter 8
Control

Chapter 8: Control Module Group

This group consists of modules performing control functions.

	Module	Basic version	optional
	**Signal Generator**	x	
	**Switch**	x	
	**Slider**	x	
	**Coded Switch**		x
	**PID Control**		x
	**Two Point Control**		x
	**Time Delay**	x	
	**Latch**	x	
	**Signal Router**		x
	**TTL Pulse Generator (Timer)**	x	
	**Stop**	x	
	**Global Variable Read**	x	

Global Variable Write x



Block Time x

Common Control Group Options:

Real Time Output

This switch, available in most Control Group modules, determines the time base at which data will be transferred to other modules.

Use Synchronization (in the Experiment Setup dialog box) to specify whether the internal PC clock or the sampling rate generated by the underlying Hardware is used as time base for all data generating modules (Generator, Slider, Switch, etc.)

If Real Time Output is switched on, data will be output in real time. A data block will not be released before the time necessary to release the number of values in the block has elapsed. This period of time is calculated from the block size and the sampling rate as they have been specified in the Experiment Setup dialog box.

Real time output only applies to slow data generation. It does not check whether data can be generated fast enough. In cases of pure simulation applications this check is left to the user in order to provide him with the ability to change parameters online. In cases of data acquisition applications, i.e., if any hardware related module is used, timing problems are noticed by the driver interface and result in an appropriate error message and stop of measurement.

Example: block size = 500; sampling rate =1000 Hz: a signal block will be output every 0.5 seconds.

If Real Time Output is switched off, data will be provided at the output as fast as possible, as soon as the next modules provide the necessary capacity. The subsequent processing modules will then synchronize the signals.

Real Time Output is useful, for example, when data signals from a Generator module are to be delivered at Analog Output. Time synchronization is then done in the Analog Output module. The Generator module generates data signals quickly enough to provide them in sufficient numbers at the Analog Output module, and **no time delay** will occur at the output.

The speed of generating data depends on the hardware and on the complexity of the experiment setup.

Options: Synchronization

Data generating modules (such as Generator without Modulation, Switch, Slider, Coded Switch, TTL Generator, Time Base without control input, and Sequence Generator without control input) provide a setting to select one of the available

time bases allowing you to synchronize the module to a specific data flow. In most cases you don't need to use a control input or synchronization.

Generally, you can choose between available time bases or choose the option to synchronize the data flow with the Input Signals of a control input.

Time Base Setup: Choose one of the available time bases to synchronize the output of the Control Group module. Use the Experiment Menu command Time Base Setup to configure available time bases.

With Input: Synchronize the data flow with a control input.

1. Signal Generator Module

Use this module to generate up to 8 or 16 different standard signals simultaneously. In the worksheet it provides these signals to the other modules using its module outputs.

Since this module provides different basic operations, you must first select the function type when you install the module.

This module provides **four** function types:

- Generator without Modulation,
- Generator with Frequency Modulation,
- Generator with Amplitude Modulation,
- Generator with Frequency and Amplitude Modulation,
- Read Global Variable.

You can insert several Generator modules in one worksheet.

- The Generator module provides several wave forms for standard signals:

Function		**The generated signal is a**...
Sine	...	sine wave of defined frequency, amplitude, offset, and phase shift.
Square	...	square wave of defined frequency, amplitude, offset, and phase shift.
Triangle	...	triangle wave of defined frequency, amplitude, offset, and phase shift.
Saw Tooth	...	saw tooth wave of defined frequency, amplitude, offset, and phase shift.
Pulse	...	periodic one-sample impulse of defined frequency, amplitude, offset, and phase shift.
Noise	...	noise signal of defined maximum amplitude and offset.
Constant	...	constant signal of defined offset.

- Frequency: This parameter determines the frequency of the generated signal. The input must be entered in Hertz. This setting is grayed out if you

selected Generator with Frequency Modulation or Generator with Frequency and Amplitude Modulation.

The time resolution and the number of samples per period is determined by the ratio between the global sampling rate, which can be specified in the Experiment Setup dialog box, and the frequency entered here.

Example: global sampling rate: 1000 Hz
signal frequency: 10 Hz
⇨ number of samples per period: 1000/10 = 100 samples

Since signal generation in this module is the digitalization of a mathematical function, the Shannon theorem applies just as it does in a data acquisition process. If the signal frequency is too high for proper digitalization, a warning message will appear.

- Amplitude and Offset: These parameters determine the amplitude range of the generated signal, specified in volts. This setting is grayed out if you selected Generator with Amplitude Modulation or Generator with Frequency and Amplitude Modulation. Depending on the defined wave form, the amplitude of the signal will be within either of the following ranges:

  - Offset minus Amplitude to Offset plus Amplitude
  - Offset to Offset plus Amplitude

  A negative amplitude will cause the waveform to be inverted; a pulse with a negative amplitude may be generated.

  There are no restrictions on either of these values, but they should be set with care regarding further calculations.

- Phase Shift Generator

  This parameter determines the phase shift for periodic signals in degrees. Allowed values are between **0º** and **359º**.

  A sine with a phase shift of **90º** is a cosine.

- Real Time Output

  This switch determines the time base at which data will be transferred to other modules.

  Use Synchronization (in the Experiment Setup dialog box) to specify whether the internal PC clock or the sampling rate generated by the underlying Hardware is used as time base for all data generating modules (Generator, Slider, Switch, etc.)

  - If Real Time Output is switched on, data will be output in real time. A data block will not be released before the time necessary to release the number of values in the block has elapsed. This period of time is calculated from the block size and the sampling rate as they have been specified in the Experiment Setup dialog box.
  - Real time output only applies to slow data generation. It does not check whether data can be generated fast enough. In cases of pure simulation applications this check is left to the user in order to pro-

vide him with the ability to change parameters online. In cases of data acquisition applications, i.e., if any hardware related module is used, timing problems are noticed by the driver interface and result in an appropriate error message and stop of measurement.

Example: block size = 500; sampling rate =1000 Hz
A signal block will be output every 0.5 seconds.

- If Real Time Output is switched off, data will be provided at the output as fast as possible, as soon as the next modules provide the necessary capacity. The subsequent processing modules will then synchronize the signals.

Real Time Output is useful, for example, when data signals from a Generator module are to be delivered at Analog Output. Time synchronization is then done in the Analog Output module. The Generator module generates data signals quickly enough to provide them in sufficient numbers at the Analog Output module, and **no time delay** will occur at the output.

The speed of generating data depends on the hardware and on the complexity of the experiment setup.

1.1. Generator without Modulation

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	same as the global block size
Max. Number of Modules:	any

You can enter the following parameters separately for each channel:

- The channel name
- The wave form
- The signal frequency
- The amplitude of the signal in Volt
- The phase shift
- The offset
- Output in Real Time mode

1.2. Generator with Frequency Modulation

Input and Output Characteristics

Number of Inputs:	same as number of outputs
Input Block Size:	same as the global block size
Number of Outputs:	up to 16
Output Block Size:	same as the global block size
Max. Number of Modules:	any

Each output channel is connected to one input channel, which delivers the Frequency for each sample to be generated by that channel.

The setup for Frequency and the Real Time Output option are disabled, since the output rate is generated from the incoming channel.

The input channel must contain normal time data. If the input channel contains gaps, the generated data stream will contain gaps too. The value of the input signal is used to determine the frequency of the generated waveform.

You can enter the following parameters separately for each channel:

- The channel name
- The wave form
- The amplitude and offset of the signal in Volts

⇨ *Since the module computes a phase correction every time the frequency changes, it takes some computation time to modulate the generator with a rapidly changing signal.*

1.3. Generator with Amplitude Modulation

Input and Output Characteristics

Number of Inputs:	same as number of outputs
Input Block Size:	same as the global block size
Number of Outputs:	up to 16
Output Block Size:	same as the global block size
Max. Number of Modules:	any

Each output channel is connected to one input channel, which delivers the Amplitude for each sample to be generated.

The setup for Amplitude and the Real Time Output option are disabled, since the output rate is generated from the incoming channel.

The input channel must contain normal time data. If the input channel contains gaps, the generated data stream will contain gaps too. The value of the input signal is used to determine the frequency of the generated waveform.

You can enter the following parameters separately for each channel:

- The channel name
- The wave form
- The signal frequency
- The offset of the signal in Volts
- The phase shift

1.4. Generator with Frequency and Amplitude Modulation

Input and Output Characteristics

Number of Inputs:	twice the number of outputs
Input Block Size:	same as the global block size
Number of Outputs:	up to 8
Output Block Size:	same as the global block size
Max. Number of Modules:	any

Each output channel is connected to two input channels, which deliver the Frequency (first input channel) and the Amplitude (second input channel) for each sample to be generated.

The setup for Frequency and Amplitude and the Real Time Output option are disabled, since the output rate is generated from the incoming channel.

The input channels must contain normal time data and with the same sample rate on the two channels. If the input channel contains gaps, the generated data stream will contain gaps too. The value of the input signal is used to determine the frequency of the generated waveform.

You can enter the following parameters separately for each channel:

- The channel name,
- The offset of the signal in Volts
- The wave form,

⇨ *Since the module computes a phase correction every time the frequency changes, it takes some computation time to modulate the generator with a rapidly changing signal.*

1.5. Generator with Get Global Variable

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	1 or same as the global block size
Max. Number of Modules:	any

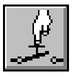
Each channel can get a different global variable that is sent to the Output as a constant value.

⇨ *You can use the Read Global Variable Module to accomplish the same task.*

You can enter the following parameters **separately** for each channel:

- The channel name,
- The Number of the global Variable,
- Output Block Size: choose one of two settings. When Global Block Size is chosen, samples are issued with that block size. When Block Size **1** is chosen, the sampling rate will be adapted to the data flow.
- Real time output option

2. Switch Module



Use this module to generate TTL compatible signals. The output can be switched manually between low and high.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	global block size
Max. Number of Modules:	any

This module generates a TTL compatible signal at each of its outputs. In a separate operation window, the output can be switched manually between low and high, or it can be set to high for the duration of one block.

Use the Switch module in combination with a Relay module or a Digital Output module for control applications and for manual operations in the course of the measurement.

Each module of this type provides an additional operation window for manipulation. That window is initially provided as an icon at the bottom of the desktop when the module is inserted into the worksheet. Double-click this icon to open the operation window; then the switches can be used.

⇨ *To use the switch as an active element in VITool, you must go to the Layout window menu item Options Menu/Layout window to select Mouse to interact with Layout window. If this function isn't active, a mouse click on the switch buttons only affect a marking of the Positioning Switch object.*

Module Configuration

In the module configuration dialog box you can enter the following parameters separately for each channel:

General Settings

- Real Time Output (see Page 8-4 for function description)
- The Color button opens a dialog box for color settings:
  - The Background button opens the Color Menu to set the color for the Text area of the channel name.
  - The Text button opens the Color Menu to set the Text color for the channel name.
- The Fonts button opens the Text dialog box to set the Font Type, Size and Color of the Status Text.
- The Options button opens the Options dialog Box to make other global settings.

Channel settings

- Switch Type: Each channel can be operated as an On/Off Switch or as a One Shot Switch. The third option, Measurement Start/Stop, creates a module that does not affect other modules but starts and stops the measurement.

Operation Window

The operation window contains (depending on the Switch Type) one or two buttons for each activated channel. Beneath the button(s) you'll find a display of the actual status of the channel: ON or OFF.

The signal can be set TTL High or TTL Low for On/Off Switch mode with the two corresponding buttons, or set for one block of data to TTL High and then automatically back to TTL Low again in One Shot Switch mode.

You can also switch using an Event Driven Action. If the event occurs, the switch toggles to the other status.

To initialize the state of the channel you can click on the buttons in the operation window. However, output will only be generated while the experiment is running. The switches can be operated by mouse clicks, but not by keyboard.

Options

You can select the following options to customize the appearance of the Status display window:

- Display

  If more than one instrument is activated in the module, you can change the Number of Columns. The arrangement of the individual instruments within the display window is determined using this setting.

The with Channel Name and with Status Text option shows or hides the channel name at the top of the instrument and the status text beside the status symbol.

- Bitmapped Graphics

  To show the Status as Symbol you can use the Default Symbol (Lamp: ON.BMP or OFF.BMP) or any Bitmapped Graphics. Activate this option using the Show Bitmap switch.

  Stretch Bitmap and Draw bitmap shows Bitmapped Graphics adapted to the window frame based on original size.

  The buttons Bitmap On and Bitmap Off open a File Select Box to select the Bitmapped Graphics Files which will be used as the On or Off Symbol.

- Synchronization:

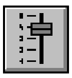
  With Synchronization you can choose whether the Global Settings or an input signal is used to synchronize data flow.

- Block Size:

  You can choose two settings in Block Size. When Global Block Size is chosen, samples are released with that block size. If Block Size **1** is chosen, the sampling rate will be adapted to the data flow.

All settings in the Option dialog box apply to all activated channels of this module.

3. Slider Module



This module generates a signal with an amplitude that can be modified manually.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	global block size
Max. Number of Modules:	any

This module generates a signal of adjustable amplitude at its output. The output amplitude can be adjusted manually in a separate operation window; the overall range of the amplitude is defined by the limiting values entered in the module configuration dialog box.

Each module of this type provides an additional operation window for manipulation. That window is initially provided as an icon at the bottom of the desktop

when the module is inserted into the worksheet. Double-click this icon to open the operation window; then the slide controls can be used.

The slide controls can be operated using the scroll bar.

Module Configuration

In the module configuration dialog box you can enter the following parameters separately for each channel:

- Min. Value / Max. Value: These two entries determine the output range the slider can generate on the selected channel.
- Resolution: Define the resolution of the slider; the number of steps between the minimum and the maximum value. With a resolution of 100, each click on the upper or lower button in the slider changes the output signal about 1%. You can define a resolution from 2 to 9999 steps.
- Real Time Output (see page 8-4 for function description)

Switches

- Options: If there is more than one active channel in the slider module you can setup the display of the operation window. You can determine the Number of Rows in the table of the sliders in the operation window and you can choose to display With Channel Name.
- With slider switch turns the slider bar on or off in the display window.
- With numerical Input fades in/out the numerical Input area.
- With Synchronization you can choose whether the Global Settings or the input signal is used to synchronize data flow.
- Colors: Click this button to setup the colors for all the parts of the operation window.
- Font: Click this button to select the type and the style of the font for the channel name. You can choose how the font is scaled. Click on the Font button to choose the font family, style and size.

  Choose from:

  Single font, fixed to specify the exact font and font size that will be displayed. One font will be used for all elements.

  Single font, automatic to allow the program to automatically resize the font when the display window is resized. One font will be used for all elements.

  Separate Fonts, fixed to specify the exact font and font size that will be displayed. You can specify different font sizes for each element: name, value and scaling.

  Separate Fonts, automatic to allow the program to automatically resize the font when the display window is resized. You can specify different font sizes for each element: name, value and scaling.

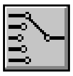
- Scaling: select a String format for the scale such as engineering or exponential format, the number of labeled ticks and the number of decimals.

Operation Window

The operation window contains one slider and one edit control for each activated channel. The slider output changes to your selection (if experiment is running) and displays the value in the edit control.

- Use the mouse and keyboard to control the slider (first the slider must get the input focus by clicking on it with the mouse).
- Or you can type the output value in the edit box under the slider.

4. Coded Switch Module (optional)



This module can generate up to 4 TTL compatible signals. These signals can be switched between the predefined 16 levels and on and off.

In the worksheet, this module can have up to 4 signal outputs.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 4
Output Block Size:	same as global block size
Max. Number of Modules:	any

This module generates a TTL compatible signal at each of its outputs. In a separate operation window, the output can be switched manually between preset levels or switched on and off. It is useful in control functions.

Each module of this type provides an additional operation window for manipulation. That window is initially provided as an icon at the bottom of the desktop when the module is inserted into the worksheet. Double-click this icon to open the operation window; then the switches can be used.

⇨ *To use the switch as an active element in the VITool you must select Mouse to interact with Layout Window in the Options Menu of the Layout Window menu. If this function isn't active, a mouse click on the switch buttons only marks the object Positioning Switch.*

Module Configuration

Open the module configuration dialog box by double-clicking on the module symbol or on the switch window.

General settings

- Real Time Output (see Page 8-4 for function description)
- Color button opens a Box for color settings:
  - The Background button opens the Color Menu to set the color for the Text area of the channel name.
  - The Text button opens the Color Menu to set the Text color of the channel name.
  - The Switch button opens the Color Menu to set the switch name color.
- The Fonts button opens the Text Dialog Box to set the Font Type, Size and Color of the Status text.
- The Options button opens the Options Dialog Box to make other global settings.

Channel settings

These settings affect only the selected channel.

Switch positions: values and display mode

Each channel has up to 16 positions. Select the number of the switch position to define the level of output. Use Display Mode to choose whether the switch position, the number of the position, a self-defined text string or the preset value with unit is displayed. If the for all positions switch is checked, the inserted unit will be displayed for all positions.

Operation Window

The operation window contains (depending on the Switch Type) one rotary switch or one button bar for each activated channel. At the perimeter of the rotary switch or in the buttons you will find the status displayed for each preset position.

- In the Button Switch mode, the signal can be set to preset values simply with a **left** mouse click on the corresponding button. The activated button is colored.
- In the List Box mode, the signal can be set to a preset value by selecting the recommended value in combo box that appears when you click the mouse on the channel.
- In the Rotary Switch mode, you must first activate a channel with a mouse click on the channel. The active channel is marked with a colored border. Now you can select the level by dragging the pointer to the displayed value with the **left** mouse button held down. You can also click on the value.

Switching only takes effect while the measurement is running. You can preset the switch to a defined start position before starting the measurement.

You can integrate several Coded Switch modules in one worksheet. Each of them has a unique module name, which is shown...

- below the icon representing the minimized operation window, and
- in the Title Bar of that window when it is activated.

The Function Bar icons and menu commands to open, minimize and arrange the display windows of the Display modules also affect Switch operation windows.

Options

You can select the following options in this window to modify the general switch display window.

- Switch mode: Use these radio buttons to select the mode switch to be displayed.
- Display: Define the number of rows and columns to arrange the switch display if more than one channel is activated. An additional status window can be activated to show the actual status of the switch.
- Channel display: If the Button switch mode is selected, this setting defines the number of rows for switch positions in between each channel.
- Mouse operation: This option selects whether the switch operation is available only by mouse or also by keyboard.
- Synchronization: You can choose whether the Global Settings or the Input Signals are used to synchronize data flow.
- Block Size: When Global Block Size is chosen, samples are released with that block size. If Block Size 1 is chosen, the sampling rate will be adapted to the data flow.

All Option Box settings apply to all activated channels of this module.

5. PID Control Module (optional)

This module implements a PID control algorithm.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	any, but the same for each pair
Number of Outputs:	number of inputs divided by 2
Output Block Size:	same as input block size
Max. Number of Modules:	any

The PID module can calculate up to 8 control signals based on the corresponding Setpoint and the current value. For each pair of module entries, the first (upper)

entry denotes the Setpoint, and the lower entry denotes the actual measured value from the controlled system. The output signal of the PID module depends on the parameter values specified for the **P**roportional, **I**ntegral and **D**erivative (**P / I / D**) components or Kr, Tv, Tn parameters.

To get the values of the parameters Kr, Tv, Tn several Parameter Identification algorithms are available. To control the settings of these parameters, use the optimization hints.

The output signal can be limited to avoid instabilities. If Control Limitation is enabled, the output signal will be bounded by the values defined as Maximum and Minimum.

You can switch between the control-characteristics manually or via action while the measurement is running, but the changed type is active after the processing of a new block starts.

⇨ *The PID control block should be used with small block sizes because the control only affects subsequent blocks.*

5.1. PID Control Circuit

A PID Control is only used when high requirements of speed and accuracy are needed. To get the optimum of settings this type of control is more demanding and complex than using simple types. There are three parameters, which have to be exactly tuned to each other, to get an optimized control behavior.

The step response of the control shows clearly its transmission characteristic. It shows the influence of the respective fundamental parameter. If at the Input of the PID control the discontinuity of the signal happens, it takes effect to the P and D part at the output immediately. Throughout the influence of the D part immediately falls to 0, the influence of I part grows slowly but continuously in time.

The **P** and **D part** effects a very **fast reaction** of the PID control, the **I part** provides the **reset of a deviation**.

To calculate the parameters use the following formula:

$$x_{aPID} = x_{aP} + x_{aI} + x_{aD} \Rightarrow x_{aPID} = K_P * x_e + \frac{1}{TI} * x_e * t + K_D * \frac{\Delta x_e}{\Delta t}$$

e = w-x (deviation), T=Sample Frequency (Time between two measurements of the controlled magnitude)

5.2. P / I / D Components

The output of the PID module consists of these three components:

- **P** proportional control constant
- **I** integral mode gain constant
- **D** derivative mode gain constant.

To set the parameters the following algorithm is used (P_Dialog = P, I_Dialog = I and D_Dialog = D):

```
REPEAT until BREAK
        e = w - x
        P_Part = P_Dialog * e
        I_Part = Last_I + I_Dialog * e * T
        D_Part = D_Dialog / T * ( e - LastDeviation )
        LastDeviation = e
        SetPoint = ( P_Part + I_Part + D_Part )
        Last_I = I_Part;
END REPEAT
```

5.2.1 Control Limitation

The output signal can be limited in order to avoid instabilities. If Control Limitation is enabled, the values specified as Minimum and Maximum will be used as the lower and upper limits for the output of the PID module. Values outside these boundaries will be cut to the corresponding boundary values.

The algorithm only checks the magnitude of the calculated values but **not** the calculated I part, so it won't be limited

The algorithm with limited Integral part not the complete set value is limited but only the Integral part is limited to a maximum or minimum. Another difference is the use f the last value of the I-part to calculate the next set value if the I-part value reaches the limit.

5.3. Kr, Tv, Tn Parameters

To set the parameters **Kr**, **Tv** (in seconds), **Tn** (in seconds) and **y0**, click on the options button.

The variables are defined as follows

$T_n = K_P / K_I$ (Reset time)

$T_v = K_D / K_P$ (Derivative time)

As described by this formula:

$$y_R(t) = K_p \left[x_d(t) + \frac{K_I}{K_P} \int xd(t)dt + \frac{K_D}{K_P} \frac{dxd(t)}{dt} \right].$$

To avoid instabilities during the control process you can limit the calculated values using the Control Limitation option. If it is enabled, the values specified as Minimum and Maximum will be used as the lower and upper limits for the output of the PID module. Values outside these boundaries will be limited to the corresponding boundary values.

5.3.1 Description of the control algorithm:

If the process deviation lasts for a longer time (i.e. starting up the process,) the I-part and the leading value y may experience a very large increase and a strong overshoot will occur. It is recommended that you limit the I part to the permissible range of the control value - for example the maximum of the bipolar Analog Output range of the data acquisition board. You also can switch off the I-part at experiment start via software.

The first way to prevent the overshoot is shown in the following description of the control program. The second can be realized while setting **sum s to zero** if a predefined **deviation is reached**. Also you can use the **actual value of s** as **constant** if the permissible deviation is reached (Value s is frozen!):

IF |e| > MaxValue

Then S := 0

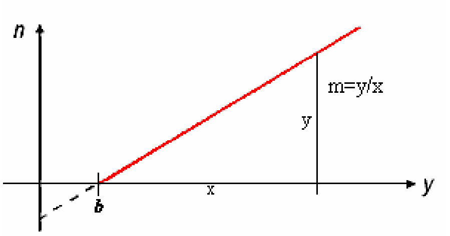
or:

If |e| <= MaxValue

Then S := S + e

Parameter $\mathbf{y_0}$ defines the needed control value - without any interference to the control circuit. I.e. if you want to control the rotation of a DC motor you can use the voltage as the regulation value. To reach special rotation you must supply the corresponding voltage. This voltage represents the $\mathbf{y_0}$! If there is interference in the circuit, the control will create a new **y** (motor voltage will change).

In **PI** or **PID** control you can set $\mathbf{y_0}$ to zero, because the Integral part of the formula decreases the regulation value **y** until the desired value is reached. In other control types, you should define $\mathbf{y_0}$ as exactly as possible. You can get them while running the control circuit without any control, thus drawing the calculated control values corresponding to the regulation into a diagram.



The picture shows such a diagram of a DC motor. This case shows the context with a simple relation:

$n = m*y + b$ (m is the inclination of the straight line and b is the value the line would cross the n axis).

With conversion you get: $y = (n-b)/m$

If a computer controls the Circuit, the controlled magnitude is no longer checked continuously but in fixed time intervals, called the scanning period T. The smallest period to reach depends on the speed of the PC. The maximum period length depends on the time response of the closed control circuit.

Such a time response occurs if the controlled magnitude changes jerkily (i.e. the motor is braked rapidly) or you set a new regulation value (**Set Point**). **Time T** has to be as maximum 10 % of the time constant of the step response. In that time the controlled magnitude will reach nearly 60 % of the new value. The maximum of scanning periods of usual control circuits with response time 100 ms (10 Hz) up to 10 seconds (0.1 Hz) is 10 ms up to some seconds.

5.3.2 Examples

Control Circuit	Delay Time T_u	Rise Time T_a
small El. Lab. Oven	0.5 ... 1 min	5 ... 15 min
large El. Lab. Oven	1 ... 3 min	10 ... 20 min
Distillation Column	1 ... 7 min	5 ... 10 min
Autoclave	30 ... 40 s	100 ... 20 min
High Press. Autoclave	10 ... 15 min	200 ... 250 min

5.3.3 Problems of Digital Controls

Basically there is the following problem in digital control:

Contrary to analog controls, digital control has the disadvantage of the stepwise output of the leading value. So the value isn't able to get each magnitude. If, for example, in rotation control, the number of rotations is changed on 100 per digit (digital staircase) and the preset nominal value is 850 rpm the control will alternately put out a leading value corresponding to 900 rpm (if nominal value is under run) and then the corresponding value of 800 rpm (if nominal value is overrun). So you will get an oscillation in rotation number. You can decrease this oscillation by using a converter with a higher resolution. A solution in software is to measure the changing of the controlled magnitude (i.e. voltage of motor) per digit of the leading value (i.e. rotations per minute) and increase the I part until the deviation is at least as big as the measured value. A program of the PID control is shown as follows:

```
S := 0;
ea := 0;

REPEAT UNTIL BREAK
   e := w-x;
   S := S + e;
   I := S * T / Tn

   IF I > max. LeadValue
   THEN S := max. LeadValue * Tn / T
```

```
    END IF

    IF I < min. LeadValue
    THEN S := min. LeadValue * Tn / T
    END IF

    D := (e - ea) * Tv / T
    ea := e
    y := Kr * (e + I + D) + yo

    IF y > max. LeadValue
    THEN y := max. LeadValue
    END IF

    IF y < min. LeadValue
    THEN y := min. LeadValue
    END IF
END REPEAT
```

Constants **w**, **T**, **Kr**, **Tn**, **Tv**, **yo** must be predefined!

Ea is the deviation of the period of previous period of measurement.

5.3.4 Control of Optimization

It is improbable that the control circuit will work optimally after first adjusting the parameters. Especially "**bad controlling"** circuits with values of **Ta / Tu < 3** will have to be adjusted. The Step Response of a change in the leading value properly shows incorrect settings of the parameters. The building-up transients allow us to conclude the needed corrections. In most cases **Tv** and **Tn** are modified at the same time. In the following pictures a PID control is presupposed

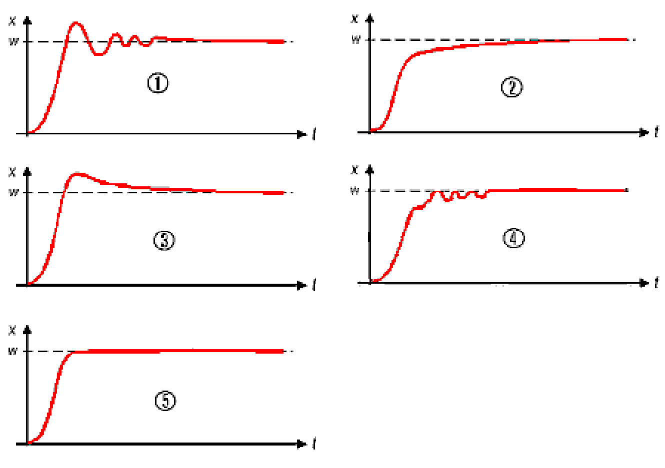
(1) I part effects strong, D part is small → use larger Tv and Tn.

(2) I part effects weak, D part is strong → use smaller Tv and Tn.

(3) P part is weak: use larger Kr.

(4) P part is strong: choose smaller Kr.

(5) The optimal control setting!



5.3.5 Parameter Identification

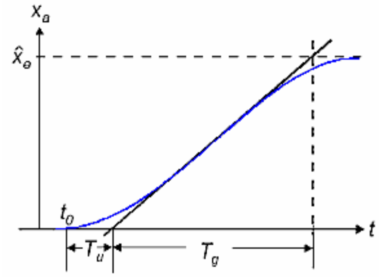
You can select one of 6 working modes using the **Kr**, **Tv**, **Tn** parameters for the PID control. You can also switch between the working modes via Action:

- **OFF**, Control is disabled (In this mode the algorithm isn't used, the leading value is set to zero. Use this mode to reach a nominal value controlled by the Sequence Generator without using the PID control in the worksheet. On reaching the nominal value, you can switch to another of the following working modes to activate the PID control.
- **ON**, Control is enabled but without any parameter identification (The preset values are used as parameter Kr, Tv, Tn and y_0 to control the circuit).
- **CHR**, Aperiodic control, good leading behavior (In this mode and in the following three modes, this program tries to set the best parameters automatically. In the first step you must arrange a step in nominal value i.e. 0V up to 5V in your control circuit. The program then runs to identify the parameters and stops switching to the working mode "ON, No use of identification parameters". Use a block size of 0 and high sample rates to perform this operation.)
- **CHR**, Aperiodic control, good disturbance response
- **CHR**, 20% Overshoot with smallest T, good leading behavior
- **CHR**, 20% Overshoot with smallest T, good disturbance response

5.3.6 Identification

In practice, the evaluation of the time response recorded, such as in the Chart Recorder, is enough to identify the parameters.

To get the time constants Tu and Ta place a tangent into the turning point of the curve as shown in picture.



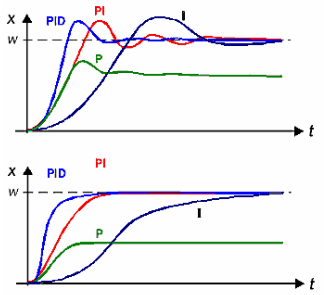
Tu is the delay time and **Ta** is the compensation time. The relationship of **Ta/Tu** shows information about the adjustability of the circuit with **T2 behavior**. To clear the context of a T2 control circuit, we look at (theoretical) circuit with large **Tu** and small **Ta**.

If input value changes during **Tu** there is no effect on the output value.The input value of the circuit as well known is the leading value **y**, output value is the controlled magnitude **x**. After expiration of **Tu** the controlled magnitude **x** will change faster the smaller **Ta** is. The real value as output magnitude of the **T2** term will quickly reach the nominal value **w** and overruns it in a large range, because the controller isn't able to react based on the large value of the delay time **Tu**. As result we get worse control behavior.

Control behavior of a T2 circuit depending on **Ta/Tu**:

Ta/Tu	**Behavior**
<3	hard to control
3 ... 10	even just to control
>10	easy to control

The results of the parameters are different depending whether you want to optimize the leading behavior or the disturbance response. To reduce the effect of a disturbance as fast as possible or to follow the leading value exactly and quickly, you have to adjust the control circuit in the right way. If you advance the last behavior you have to choose a smaller reset time. So the influence of the I-part will increase.



The parameter settings consider whether the control works aperiodically or with 20 % overrun. The mode with overrun effects the shortest rise time. The picture shows the time responses of the different types of controller.

5.3.7 Settings with the CHR approximation method

The approximation method named of CHIEN, HRONES and RESWICK (CHR) is a useful algorithm to calculate the control parameters if the properties of the circuit are known. These parameters Ks, Tu and Ta can be investigated with the evaluation of the time response, so it is especially useful in practice.

	Aperiodic control with shortest oscillation duration		20 % overrun with shortest oscillation duration	
	leading	**disturbance**	**leading**	**disturbance**
Kr	0.6 * Ta / (Tu*Ks)	0.95 * Ta / (Tu*Ks)	0.95 * Ta / (Tu*Ks)	1.2 * Ta / (Tu*Ks)
Tn	1*Ta	2.4*Tu	1.35*Ta	2*Tu
Tv	0.5*Tu	0.42*Tu	0.47*Tu	0.42*Tu

5.3.8 Working modes of Parameter Identification:

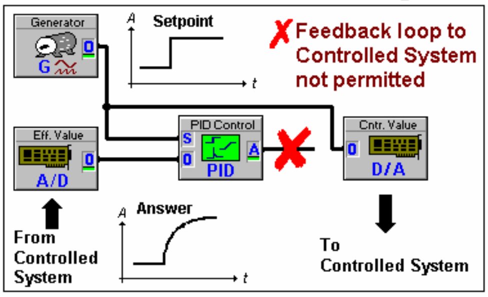
- CHR, Aperiodic control, good leading behavior
- CHR, Aperiodic control, good disturbance response
- CHR, 20% Overrun with smallest T, good leading behavior
- CHR, 20% Overrun with smallest T, good disturbance response

5.3.9 Identification in Data Acquisition Software

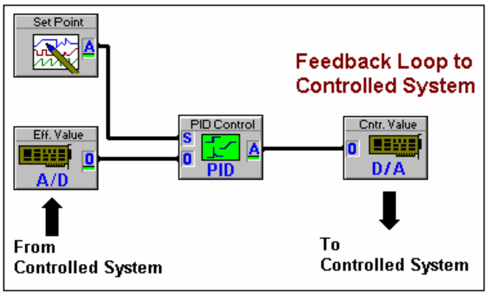
- Select one of the modes of parameter identification in the PID Module (Mode **Kr**, **Tv**, **Tn** parameter).

  Ehen the identification is performed, you cannot feedback the output of the PID module to the input of the controlled system. The inputs of the PID module **and** the controlled system geth the same step function.

Configuration Running Autotuning



Configuration Running Experiment



- Create a step function (i.e. with Sequence generator module; 0V through 5V).
- Use the highest possible sampling rate with a block size of 1.
- Start measurement.
- The results are inserted in the according fields in dialog of the PID module. The module automatically switches to the No parameter identification working mode. Now you can start measurement with the investigated parameters.

⇨ If the **Kr**, **Tv** and **Tn** parameters are defined using global variables (source is the slider, for example) after identification the parameters are sent back by the PID module. These values are available for further correction.

5.3.10 Action

You can use the Action Module to switch the

- Type of control: 1 =PID with P, I, D; 2 =PID with Kr, Tv, Tn
- Working Mode:

  1 = circuit control is off

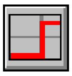
  2 = circuit control is on, but no use of parameter identification

3 = CHR, Aperiodic control, good leading behavior
4 = CHR, Aperiodic control, good disturbance response
5 = CHR, 20% Overrun with smallest T, good leading behavior
6 = CHR, 20% Overrun with smallest T, good disturbance response

- reset control

The reset in control with P, I, D will reset the last I part with respect to the deviation reset in control with Kr, Tv, Tn sum will be reset.
The input of other values in the Action Module won't have an effect.

6. Two Point Control (optional)



Use this module to process data in the manner of a two-point controller

Input and Output Characteristics

Number of Inputs: up to 8 pairs of values
Input Block Size: any, but in pairs the same
Number of Outputs: half the number of inputs
Output Block Size: as input
Max. Number of Modules: any

In the worksheet this module can process up to 8 Two-position control loops. Each control output has one input used for the desired value, marked by the s symbol, and one input for true value, marked by the channel number. The incoming data has to be time-based data.

Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

You can choose between the following different types to control:

- Control by switch free range of tolerance
- Control by premature switching
- Control by delayed feedback
- Control by delayed yielding feedback

To trigger subsequent switches and relays, you can define whether the switch-on value at the module output is TTL-High (switch-off with TTL-Low) or TTL-Low (switch off with TTL-High) signal.

6.1. Two-point control: Change type of control via action

You can switch between types of control during measurement via the Action module. To select the different types you have to use the following entries in parameter field "change control":"

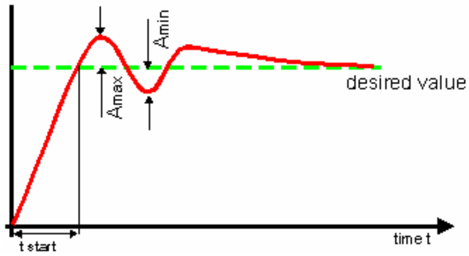
1 control with switch free range of tolerance
2 control with premature switching
3 control with delayed feedback
4 control with delayed yielding feedback

Other values won't take any effect, so no action will be performed.

⇨ Before starting measurement, define useful parameter of the individual types of control in the accompanying channels of the module.

Hints: To select the correct type of control to be useful in your application you should consider the following quality criterions:

- Time to reach the requested desired value tstart
- Maximum of overshoots appearing after reaching the desired value Amax
- Minimum of undershoots appearing after reaching the desired value Amin
- Switching operations of switching element (Relay)



To reduce the latency, the Two-point control should (such as each controller in ***ServiceLab***) be used with a small block size (near 1).

The parameter to define the several control characteristics (settings in Options dialog box) can also be set using Global Variables. To ascertain the parameter of the control loop the CHR (*Chien Hrones Reswick* approximation) or *Ziegler and Nichols* algorithm is recommended.

You are allowed to change control characteristics during measurement.

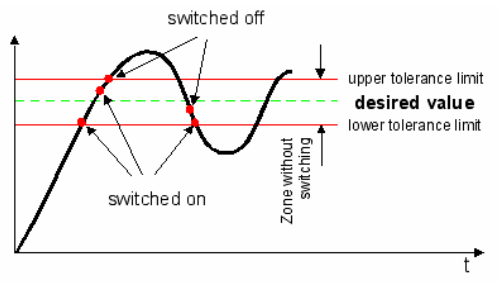
You can switch

- manually or
- using an event driven Action

Note: the characteristic will change at that moment a new data block comes into progress.

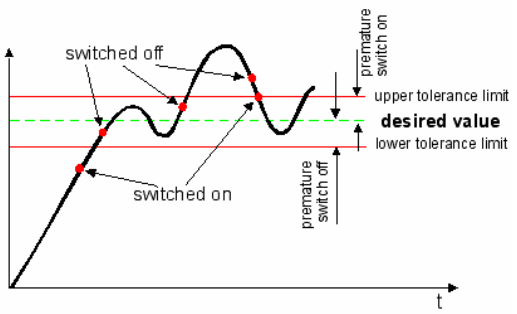
6.2. Control with switch free range of tolerance

In this mode you are able to increase the hysteresis, so you will create artificial inertia in the system. Define a switch free range of tolerance (Setting as a percent of the desired value) around the desired value between level (TTL-High or TTL-Low) should not change.



6.3. Control with premature switching

Two-point controls followed by switches (relays) always have hystereses. Switching on is always at a higher level than switching off, because magnetic fields, friction and other influences shift the break-over point. Because of the hysteresis, the Two-point control won't switch off if the desired value is reached. The break-over point is reached at **x = w + xL**. If control is switched off, the controlled condition follows the turn-off curve until the value **x = w - xL** is reached and switches on. This cycle repeats with the constant fluctuation range of **2 * xL**. To minimize fluctuations, it is necessary to **minimize the hysteresis xL**.



To reduce the delays at the break over points, you can change the switching level prematurely. If the true value approximates the desired upper value, you can, for example, turn off the heat or turn on a cooling fan. If the true value approximates the desired lower value you can turn on the heater or turn off the fan. You can define the upper and lower break-over point separately (as a percentage of desired values).

6.4. Control with delayed feedback

Control is disturbed by the **periodic fluctuation** of the control value. It increases in control loops with large delay times. Normally you can't change the loop pa-

rameters, so you can improve behavior of these loops only by modifying the controller itself.

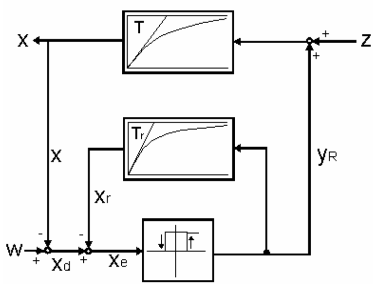
First, let's take a look onto the reasons for large fluctuations:

We intend a simple Two-point control without a base load and with surplus power of 100 % (w = ½ * x_{max}). In the time 2 * T_u, the complete 100 % power was switched on. This causes a power push of Y_h * 2 * T_u. Because of the inertia of the control loop, this push is seen as an overshot of the reference magnitude. The larger the delay of the control loop, the longer the power will stay and the fluctuation margin d_x will also increase.

If controller could switch more often than at 2 * T_u, the magnitude of power pushes and the fluctuation would decrease. Of course, you must accept a higher switching frequency, but this is not a problem when using electronic switching components (Thyristors, Triacs, Transistors).

This behavior of the controller is reached by using:

The control response of a Two-point control is mainly affected by the properties of the control loop. For example, in a control loop with delay and dead time period length and where the amplitude depends on the ratio Tt / T. Using feedback, the constant hunting around the desired value is nearly removed. With appropriate feedback components, you can force a time response similar to a continuous action controller. This type of control is called continuous equal-type control.



The Two-point control with the feedback presents a closed loop, so it is it's own control loop inside the "external" control loop. T1, the time constant of the feedback element (Input as seconds) is defined much smaller than the loop constant Tg. This causes a faster increase of xr than the reference magnitude x, so breakover points are reached earlier.

Output quantity **xr (t)** is still affected by **K1** in the following formula.

$$x_r(t) = y_{R0} \cdot K_r \left(1 - e^{-\frac{t}{Tr}}\right)$$

If the time constants of the controlled system and feedback are favorably tuned, the switching cycles at the output of the controlled system are nearly undetectable, so the result is comparable to continuous control. More exact theoretical

examination shows the behavior of a Two-point control with delayed feedback is similar to the continuous PID control.

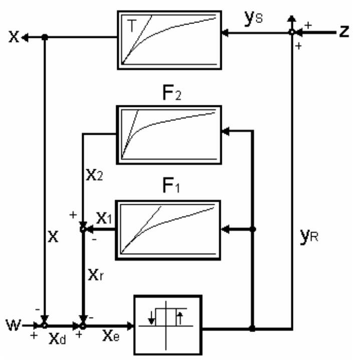
6.5. Control with delayed yielding feedback

The theoretical preliminary background for this type of control is the same as in the description for control with delayed feedback type.

If a feedback element is selected with different transient response, you can remove the remaining deviation.

Recommended behavior is the delayed yielding feedback. If the excitation is jerky this control device starts with a delayed output quantity, reaches a maximum and decreases to zero.

A delayed yielding element is built by two T1 elements used in parallel with different time constants. The output magnitudes are subtracted.



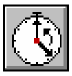
The **xr (t)** output quantity is affected by **K1a, T1a, K1b** and **T1b** in the formula.

$$x_{1(t)} = y_{R1} * K_{1a}(1 - e^{\frac{-t}{T1a}})$$

$$x_{1(t)} = y_{R1} * K_{1a}(1 - e^{\frac{-t}{T1a}})$$

A control with delayed yielding feedback shows a similar response to the continuous PID control.

7. Time Delay Module



Use this module to generate a time delay in the signal flow by preceding the incoming signal with a defined number of blocks of zero values. Then, the delayed data will be transferred unchanged.

Input and Output Characteristics

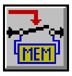
Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

This module delays the incoming signal for an adjustable number of blocks. The delayed part of the signal is stored in this module and passed on to the output *n* blocks later. The first *n* blocks are filled with zero values. This module is necessary if an application requires closed data loops.

The Enable Signal Loops option defines the main working mode of the module.

- If the option is activated you can feedback signals. So you are able to send signals back to the input of already processed modules (e.g. for simulation of PID loops). In this case, the signal at the input must have exactly the same signal sampling rate and block size.
- If the option is disabled each kind of data may be processed, but signal loops are not available in that mode.

8. Latch Module



Since this module provides** four basic operations, **you must first select the function type when you install the module.

This module provides **four** function types:

- Data throughput depending on set input,
- Latch all channels on action,
- Latch all channels on TTL high on set input,
- Set Global Variable
- Synchronize output data rate to set input.

8.1. Data throughput depending on set input

This module passes an input channel through or keeps the last data value (with constant output) - depending on the state of the control signal.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs (1 data input and 1 control input)
Input Block Size:	same as global block size
Number of Outputs:	up to 8 (same as input pairs)
Output Block Size:	same as input
Max. Number of Modules:	any

This module provides 1 data input and 1 control input per channel for each data output. The upper of the 2 inputs is the control input and the lower one the data input.

- If a TTL High level (5 Volt) is present at the control input the data at the data input is simply passed through.
- If a TTL Low level (0 Volt) is present at the control input, the last data value (at which the control input was at High level) is latched as long as the Low-level signal is present.

At the beginning of the measurement 0 is output until the control input is set to High level the first time.

8.2. Latch all channels on action

This module passes an input channel through or keeps the last data value (with constant output) - depending on the asynchronous action "Generate Data"

In the worksheet this module can process up to 16 data channel.

Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	same as global block size
Number of Outputs:	up to 16 (same as inputs)
Output Block Size:	1
Max. Number of Modules:	any

At the beginning of the measurement the output is **0** until the first value is received.

This module can work in **two modes**:

- If Output of one value is chosen, 0 is output when the measurement starts, until the event defined in the Action module occurs. The output value has the start time of the Action and a block size of 1.
- If Output of one complete data block is chosen, blocks filled with 0 are output when the measurement starts, until the event defined in the Action module occurs. The output block has the start time of the action with an unchanged block size.

Sampling rate is: $\frac{\text{global Sampling rate}}{\text{Block Size at input.}}$

Input channels are allowed to have different sampling rates and channel types. The last received value is sent to Output.

8.3. Latch all channels on TTL high on set input

This module passes an input channel through or keeps the last data value (with constant output) - depending on the TTL level of the control signal.

In the worksheet this module can process up to 15 data channels. Channel 16 is always the control channel. Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

Input and Output Characteristics

Number of Inputs:	up to 15
Input Block Size:	same as global block size
Number of Outputs:	up to 15 (same as inputs)
Output Block Size:	1
Max. Number of Modules:	any

This module may be used in two different modes.

8.3.1 Mode 1: Output of one single value

At the start of the measurement the output is **0** until the first value is received. If at least one TTL high level (5 Volts) is present at the control input, each output channel will output one block of data with size 1 with the same starting time as the block at set input.

Sampling rate is: $\frac{\text{global Sampling rate}}{\text{Block Size at input.}}$

If several TTL High levels are detected in one block (depending on global sampling rate and Block Size) only the first value is considered. The module ignores all TTL high level values until next block starts. This ensures blocks with monotonically increasing start times.

8.3.2 Mode 2: Output of one complete block

At the beginning of the measurement, the output block is filled with **0** until the first value block is received. The block length at control and data inputs has to be the same (otherwise the measurement stops), but may be different in type (e.g. normal sample at the control, FFT data at the data inputs). At the output, the data type, sampling rate and block size are the same as the corresponding input. If the block at the control inputs contains at **least one** TTL-high value, the actual data block is sent as the new block to the output. Otherwise the last block is output.

8.4. Synchronize output data rate to set-input

This module synchronizes the samples of up to 15 data channels to the data rate of the set input.

Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

Input and Output Characteristics

Number of Inputs:	up to 15 data inputs + 1 set input
Input Block Size:	same as global block size
Number of Outputs:	up to 15 (same as data inputs)
Output Block Size:	same as set input
Max. Number of Modules:	any

All values at the output are the same as the input values, but data rates are adapted to the Set input (synchronized). Type of data, block size and sampling rate of the output data are the same as the data at the set-input.

This module is able to synchronize data of different channels to same data rate, allowing these data channels to be processed in common.

8.5. Set Global Variable

This module writes an input channel into a Global Variable.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	same as global block size
Number of Outputs:	up to 16 (same as inputs)
Output Block Size:	1
Max. Number of Modules:	any

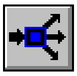
Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

Input values are written into the defined Global Variable. You can select whether the module passes through the signals. Channels are independent, but it is also allowed to write into the same variables.

There are two options:

- Global variable will be refreshed with each received data block.
- Global variable is refreshed by the Set global variable event driven Action.

9. Signal Router (optional)



*This module uses **a control input to determine which output channel will be activated***

Input and Output Characteristics

Number of Inputs:	15, with one control input
Input Block Size:	as input
Number of Outputs:	up to 15
Output Block Size:	as input
Max. Number of Modules:	any

Depending on the signal at the control input or on a defined time the module can switch the input signal to one of up to 16 output channels. Only one output receives data at a time. Use this module to control the data flow between two or more exclusive operations.

In the worksheet, this module can have up to 16 signal outputs.

Since this module provides different basic operations, you must first select the function type when you install the module. This module provides two function types:

- Amplitude controlled
- Time controlled

9.1. Input Controlled Router

Input and Output Characteristics

Number of Inputs:	1 with one control
Input Block Size:	as input
Number of Outputs:	up to 16
Output Block Size:	global block size
Max. Number of Modules:	any

Depending on the signal at the control input the module can switch the input signal to one of up to 16 output channels. Only one output receives data at a time. Use this module to control the data flow between two or more exclusive operations.

Module Settings

The Control Input... setting controls the operation of the module using the value at the control input. This setting is valid for all channels.

- Edge Controlled Increment**:** If the input signal receives a rising edge, the module switches the output to the next active channel.
- Edge Controlled Decrement: If the input signal gets a rising edge the module switches the output to the next active channel.

- Amplitude controlled: Depending on the amplitude of the signal at the control input the module (truncating the decimals) switches the output to the corresponding channel. (e.g. Level is 5.3 V -> Channel 5 ; 0.7 V -> Channel 0).

9.2. Amplitude Controlled Router

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	global block size
Max. Number of Modules:	any

General Settings

If the Restart at the end of cycle option is active, the module starts again with channel 0 when the last active channel is reached. If the option is disabled, the input is routed to the last channel when the last channel is reached. You can use an Event Driven Action to reset to the start of the cycle, or to go back one channel, or go forward one channel.

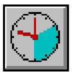
Channel Specific Settings

The Router schedule for this channel setting defines the time interval the module has to wait to switch from the active to the next channel. This setting is specific for the selected channel. The value in the edit field defines the length of interval.

You can use

- blocks
- seconds
- minutes
- hours

10. TTL Pulse Generator Module (Timer)



This module can generate TTL compatible signals according to the defined duty cycles.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	global block size
Max. Number of Modules:	any

The module generates TTL compatible signals with definable low and high phases. TTL high equals 5, TTL low equals 0. Like the Generator module, this signal is provided at the global block size and sampling rate.

- The low and high cycles will be generated using the duration defined in Phase 1. The phase duration can be defined in seconds, minutes, hours, days or samples. The settings of Phase 2 are computed from the settings in Phase 1.
- Level Phase 1: define the level (TTL low or TTL high) with which Phase 1 starts.

  If a value is entered for the Stop after ... Cycles option, signal generation will be stopped after the entered number of cycles. If no value is entered or if it is **0**, the time slice will run continuously
- Start defines the start time of phase 1:

  at once: Phase 1 starts with starting measurement.

  after delay: Phase 1 begins after expiration of time defined in field time.

  at time: Phase 1 starts at the in field time defined time (base system time). Format defines whether date also will be considered to start phase 1.
- Restart cycle: You can define the time the cycle will restart with phase 1:

  After measure time: Restart begins after expiration of time defined in time field**.**

  hour: This button is active if as the time base day is chosen. The restart of cycle begins on x day at hh:mm:ss hour.
- If a value is entered for the Stop after ... Cycles option, signal generation will be stopped after the entered number of cycles. If no value is entered or if it is 0, the Time Slice will run continuously.

Button Options

This button opens a dialog box to define the synchronization and block size used in this module.

11. Stop Module

This module pauses or stops the entire measurement if certain predefined conditions are fulfilled.

Input and Output Characteristics

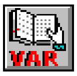
Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	any

This module can pause or stop a running measurement following conditions dependent on the data values. The effect is the same as pausing or stopping the measurement using menu commands or the Function Bar icons.

Action determines whether the measurement is to be paused or stopped. The action will be performed when specified conditions are fulfilled:

Function	Condition: action carried out ...	Parameter
Blocks	… after the defined number of data blocks	number of blocks
Samples	… after the defined number of samples	number of samples
Seconds **Minutes** **Hours**	… after the defined time	time in selected unit
Low Level	… at a TTL low level of 0.8 (= Below Limit/Parameter set to 0.8)	---
High Level	… at a TTL high level of 2.0 (= Exceeding Limit/Parameter set to 2.0)	---
Below Limit	… if signal values fall below specified level	limit
Exceeding Limit	… if signal values exceed the specified level	limit
Never	… the action will not be performed at all (no operation)	---

12. Global Variable Read



*Use this module to **generate a data channel** using the value of a specified Global Variable*

Input and Output Characteristics

Number of Inputs:	(1 control input)
Input Block Size:	global, or as control input
Number of Outputs:	up to 16
Output Block Size:	global or 1
Max. Number of Modules:	any

In the worksheet this module can read up to 16 different Global Variables and put these values to the outputs.

Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

The following settings are valid for all channels:

- Synchronization: The module output can be synchronized with one of the available time bases or with a control-input. If the Input option is selected, the module has an input marked with I. In this mode the output of the module will be synchronized with the stream of data received at the control-input. It will use the same time stamp and block information as the input channel.
- Block Size at the Output :The output of the global variable channel can use the global block size defined in the time base or it can use a fixed block size of 1. If a block size of 1 is selected, one value is sent to the output with each block of data (global setting). The sampling rate in that case is adapted as follows:

  Example: global sampling rate 1 kHz , Block Size 512 => (1000/512)= adapted sampling rate1.95

The following settings are valid only for the active channel.

- Global Variable: Specify, for each channel, the name of the global variable to be sent to the corresponding output. Right mouse click to open the context menu where Global Variables... opens a list box to select one of the available variables.

  Use the arrow button at the right to move the selected channel to the next channel. If there is no activated channel, the next channel will be activated with the next variable in numerical order selected.
- Use defined prefix as channel name: Choose this option to use the description defined in the global variables setting as the channel name.

- If Real Time Output is switched on, data is output in real time. A block is not sent to the next module until a full block of data values is ready.

13. Global Variable Write

Use this module to ***save a data channel to a specified Global Variable***

Input and Output Characteristics

Number of Inputs:	16
Input Block Size:	global
Number of Outputs:	---
Output Block Size:	----
Max. Number of Modules:	any

In the worksheet this module can save up to 16 different Global Variables.

Use the Channel Bar to specify the number of channels and the variable to be set (selected channel).

The following settings are valid for all channels:

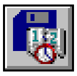
- With Every Input Block: The Global Variables are refreshed each time a complete block is received.
- On Action: The Global Variables are refreshed by an action of an Action module.

The following settings are valid only for the active channel.

- Global Variable: Specify, for each channel, the name of the global variable to be sent to the corresponding output. Right mouse click to open the context menu where Global Variables... opens a list box to select one of the available variables.

  Use the arrow button at the right to move the selected channel to the next channel. If there is no activated channel the next channel will be activated and the next variable in numerical order is selected.
- The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is sent unchanged to the output.

14. Block Time (optional)



This ***module extracts the time stamp*** *information from the current data block and* ***writes it to the defined global strings****.*

Input and Output Characteristics

Number of Inputs:	16
Input Block Size:	any
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	any

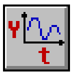
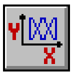
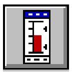
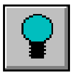
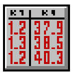
Module Settings

Use the parameter settings to define the global strings to store the Time and Date information. Use the check boxes to suppress the information.

Chapter 9
Display

Chapter 9: Display Module Group

This group consists of modules which display or present the data.

	Module	Basic version	optional
	**Y/t Chart**	x	
	**X/Y Chart**	x	
	**Chart Recorder**	x	
	**Analog Meter**	x	
	**Digital Meter**	x	
	**Bar Graph**	x	
	**Status Lamp**	x	
	**List Display**	x	

Overview

The modules of the Display module group differ from other modules. After selecting a Display module from the Module menu or the module bar, it creates two elements: a worksheet symbol on the worksheet and a display window icon at the bottom of the screen in the ***ServiceLab*** tree view and in the worksheet view. A display module presents data blocks in a graphical or numerical way.

- The **worksheet symbol** is integrated into the worksheet and connected to the other modules by data channels,
- The **icon** represents a **separate window,** which you must **restore** (or "open") whenever you wish to use the display function during an experiment.

- Display windows of some display modules have separate menu systems to select display options or functions.
- While the experiment is running, Event Driven Actions can influence some of these display options, if a selected event occurs.
- The text and numerical value format of the display modules are specified by the Country Specific Setup that can be set using the Windows Control Panel.

You can integrate several display modules of the same type. Each of them has its own name, which is shown in the icon and the window.

You can restore or minimize all the display windows contained in the worksheet simultaneously by choosing Show Display Windows or Hide Display Windows from the View menu, or, by clicking their Function Bar icons.

You can restore each of the display windows contained in your worksheet individually by double-clicking its icon at the bottom of the screen. You can minimize each of the display windows individually by clicking its Minimize button in the upper right-hand corner of the display window.

Four of the modules can display a single sample from the data block (first, last, maximum, minimum, etc.). Four of the modules display a complete block, or multiple blocks of data at one time.

Display Module	Maximum Input Channels	Display Mode
Analog Meter	16	Single Data point
Digital Meter	16	Single Data point
Bar Graph	16	Single Data point
Status Lamp	8	Single Data point
Y/t Chart	16	Data Block
X/Y Chart	2x8	Data Block
Chart Recorder	16	Data Block (continuously)
List Display	16	Data Block

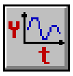
The choice of display module depends on the type of data to be displayed and the sampling rate. The charts below shows which types of data can be displayed in each display module, and which modules are more suited to fast or slow sampling rates.

	Trigger Data	Trigger and Normal Data	Histogram Data	Frequency Data
Analog Meter	●			●
Digital Meter	●			●
Bar Graph	●			●

Status Lamp	●			●
Y/t Chart	●		●	●
X/Y Chart	●			●
Chart Recorder	●	●		●
List Display	●			●

Block Size:	**Small**	**Small**	**Large**	**Large**
Sampling Rate:	**Slow**	**Fast**	**Slow**	**Fast**
Analog Meter	●		●	
Digital Meter	●	●	●	●
Bar Graph	●		●	
Status Lamp	●	●	●	
Y/t Chart		●	●	●
X/Y Chart	●	●	●	●
Chart Recorder	●		●	
List Display	●		●	

1. Y/t Chart Module



In a separate** Y/t Chart Display Window, **this module displays blocks of data as time or frequency dependent curves.

This module is most useful for displaying **fast** data, since it always processes at **least one complete block** of input signals to display at one time. Using it with very slow signals may cause long acquisition pauses. For slower data inputs, the Chart Recorder module would be more appropriate.

***ServiceLab** distinguishes between time-dependent, frequency-dependent, histogram, continuous, and triggered data. Signals of different data types cannot be displayed in one Y/t Chart module. At least one Y/t Chart module must be used for each type.*

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The data will be displayed in the Y/t Chart Display Window attached to each module and tagged with the same module name. Double-clicking its icon at the bottom of the desktop can open the display window.

The global parameters for the display can be entered in the module configuration dialog box. These parameters define the scaling of the X-axis or types of X axes as well as curve-dependent values like amplitude scaling and the selection of units. The number of curves to be displayed can be chosen using the Channel Bar.

Global Settings (all activated channels)

- Zooming: set Zooming Options to constrain how zooming expands the display area.
  - If the Auto Scaling is selected, all values of the data block are tested for maximum and minimum values before they are displayed. The chart is scaled and displayed using these values. Use this function to ensure that peaks will be displayed regardless of value.

    Note that the scaling can change continuously and will slow down the display speed.
  - X and Y Direction: The display area is expanded exactly as selected with the Zoom cursor.

- Only Y Direction: The display area zooms only in the vertical direction as selected. The scale of the X-axis remains as defined.
- Only X Direction: The display area zooms only in the horizontal direction as selected. The scale of the Y-axis remains as defined.
- The number of curves to be displayed can be chosen using the Channel Bar.
- The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Specific Channel Settings

These settings apply only to the selected channel.

- The Unit can be specified.
- To modify the Y Scaling, click on the Y Scaling Button.
- To modify the X Scaling, including the mode, the channel type, display width, and time scale, click on the X Scaling button.
- To display an additional Reference Curve in the display window, use the Reference Curve button to open the settings dialog.

⇨ *Before using this option use the Reference Curve Module to create a useful Reference Curve.*

Some of these parameters may also be modified using the display window menu functions. These menus offer several additional display options, including the selection of colors, fonts or line styles. All the commands for interactive graphical analysis of curves, like zooming or measuring cursors, are available.

1.1. X-Axis Settings - Time Scale

Channel Type

- Automatically: This option sets the X-axis labeling to seconds, minutes and hours from the start of the measurement. Each time the display is updated, the X-axis is also updated. Minutes or hours are only displayed when necessary.
- Time data: The X-axis is shown starting at zero up to the time corresponding to the block length. This scale is fixed.
- Frequency data: This setting is only useful with FFT data. A frequency scale is shown.
- Histogram data: This setting is only useful with Histogram data.

  Free: This option offers a largely free setting of axis parameter.

Additionally, the following options for X axis scaling are available:

- Use Scale to define the number of labeled and blank ticks to display on the axis.

- If the step dx switch is used, you can define an exact distance between two ticks based on the in unit defined value.

1.1.1 Time Scale

Running Time Scale: This time scale uses the elapsed time since the start of the measurement to label the X-axis. The time is displayed in seconds, minutes and hours. The axis will be updated for each block.

Fixed Time Scale: This time scale uses the internal time scale of each displayed block. The axis will be the same for each block starting at 0.

The duration of the interval to be displayed can be specified in the dialog box. The display width can be specified as either blocks or as seconds. The default is the display of exactly one block.

- If the length is entered in blocks, the specified number of blocks will be collected and displayed simultaneously.
- If the length is entered in seconds, data will be collected and displayed according to the defined time.

If the display interval is too short to contain more than one sample, every sample will be displayed as a straight horizontal line.

You can switch between the scaling options while the experiment is running.

These settings should be chosen considering the following:

- While a minimum limit does not exist, only one line for every sample is drawn if the chosen display width is less than or equal to the sampling rate of a data channel.
- The maximum setting depends on the sample distance of the display channels and on the physical memory available on your computer.
- The experiment stops with an error message if the number of blocks or time specification is too large.

Display Mode

- Standard: When the number of blocks, as defined in the interval to be displayed, is reached, the window will be updated. The window contents are completely redrawn.
- Fast**:** Each new block is displayed after the previously displayed value. The first value in the display window is removed.
- Wiper: The new values are displayed after the previously received value until the complete display interval is used. Then the new values are displayed at the beginning of the display window, overwriting the already displayed values. The Window will be wiped out from the left to the right. To get a typical display, the interval should be >10. There will be no display of values with the standard setting of 1.

If the Show wiper option is active, a vertical line appears in the display marking the point where new values are plotted.

- Use Zoom to define the range to be displayed if the Zoom function is activated.

1.2. Y Scale... (Amplitude Scaling)

You can also double click with **left mouse button** on the axis to open the dialog box for setting the scale ranges for each curve.

Use Settings to set the display range of the channel. Choose the Auto option to use the default settings. Choose user defined to change the Scale and String format settings.

Use Scale to define the number of labeled and blank ticks to display on the axis.

String format allows you to choose normal, exponential and Engineer format as the displayed number on the axis.

If you deactivate Display Channel, that curve will not be drawn, and the drawing area for that curve will remain empty (although signals are correctly received at the module input). If you have selected that channel's scale to be displayed, it will still be provided in the display window in the One Chart mode (although none of the traces actually drawn refer to it).

If you choose the logarithmic scaling, the Y-axis is scaled using a logarithmic scale. Use this option, for example, to display FFT data channels. Note that the display range must be greater than 0.

If only one Y scale, but several channels, are displayed in one Y/t Chart module, you can select a single channel to display its scale by clicking the **left** mouse button inside the corresponding color or legend area (fast switch).

1.3. Reference Curve

Display Reference Curve activates the display of the Reference Curve function. Additionally, you can display a tolerance range with maximum and/or minimum values. The following options define this tolerance band:

- Min/Max
- Reference Curve ± Percentage
- Reference Curve ± (Constant + Percentage)
- Reference Curve ± Constant
- Reference Curve ± (n x standard deviation)

The desired settings are entered in the edit field below the options.

The Display option allows you to modify the tolerance band display. You can choose several options, starting with a simple line up to a fully filled exclusion area.

The Color**...** button opens the color selection menu to select the color used in the tolerance band.

The Replay Reference Curve Option re-starts the reference curve if the end of the file is reached. This allows you to use a "short" Reference file to check long-time or open-ended experiments.

In the Reference Curve area the selected Reference Curve file is shown. The File... button opens the file menu to choose a Reference Curve file.

Before using this option, use the Reference Curve Module to create a useful Reference Curve.

Display Window

The data will be displayed in a display window (the Y/t Chart Display Window) associated with each module and tagged with the same module name. Double-clicking its icon at the bottom of the desktop can open the display window.

The display window associated with the Y/t Chart module can display up to 16 signal curves simultaneously in one diagram. The data values are always displayed in blocks. As soon as a new block is complete, the previous display is deleted and the new values are displayed.

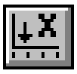
The display window menu system offers several additional display options, including the selection of colors, fonts or line styles. In addition, all the necessary commands for interactive graphical analysis of curves, like zooming or measuring cursors, are available.

1.4. Display Window Menu Options

The display style and the interactive graphic commands can be chosen from the menu or the Function Bar.

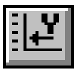
1.5. Axes Functions

X-Scale



Choose this command to define the X-axis (time, frequency, bins) scale ranges for the Y/t Chart. All the displayed curves use one joint X-axis that is chosen from the X-axis dialog box of the Y/t Chart module or from the Menu or Function Bar of the Y/t Chart Display Window. See above for details.

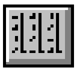
Y Scale... (Amplitude Scaling)



Choose this command to define Y-axis scale ranges for each curve. The left part of the dialog box displays the channel list. Each channel activated in the module configuration dialog box is represented as Input X (X denoting the number of the activated channel). Select (highlight) the channel whose settings you wish to modify. See above for details.

If only one Y scale, but several channels, are displayed in one Y/t Chart module, you can select a single channel to display its scale by clicking the **left** mouse button inside the corresponding color or legend area (fast switch).

Scaling Options



Use this command to determine how many scales, and which ones, are to be provided in the display window. These settings are primarily used for multi-trace display, where more than one channel has been activated for display. Only the One Chart mode will be affected, unless you deactivate scaling.

Up to four different amplitude scales can be assigned to each display window. These scales can be related to the inputs that are to be displayed. The scaling boundaries of these curves are then displayed on the related scales.

In the Multiple Chart mode, an appropriate scale is derived from the display range values in the Amplitude Scale dialog box. It will be placed next to the curve display to which it belongs.

No more than **four** different scales can be activated in the One Chart mode. The scales will be arranged next to each other on the left and on the right of the drawing area for the concentrated traces.

- The left part of the dialog box displays the channel list. Each channel activated in the module configuration dialog box is represented as Input X (X denoting the number of the activated channel). Select (highlight) the channel you wish to assign to a scale. The channels already assigned cannot be reused.
- Then press one of the four arrow buttons on the right. Initially you must assign the scales in ascending order. Once they have been assigned a channel from the list, you may change any entry.
- To turn a scale off, choose Off in the channel selection list and “assign” it to that scale. You can only turn the **last** of the assigned scales off. If you turn them all off one by one, no scale will be displayed.

⇨ *A scale selected here will be displayed even if the associated trace will not be displayed because you have deactivated Display Channel in the Amplitude Scale dialog box.*

⇨ *Because of the four scales restriction in the One Chart mode, there may be traces drawn in the drawing area for which exact scaling is not possible, as their scales cannot be displayed. Their values may differ considerably from the values that the displayed scales indicate.*

1.6. Display Functions

Function Bar/Menu

The Function Bar contains icons that provide easy access to frequently used functions and options from the display window menus. Just click the icon representing that function.

A check mark (✓) indicates that the Function Bar or the Menu is displayed. All the commands represented on the Function Bar are also available from the menus. You can click over the Display Window with the **right** mouse button to display a short cut menu that contains all of the menu options.

Window

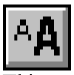
One Chart mode displays all the curves in one combined diagram. The individual traces may cross each other. The advantage of this mode is that maximum resolution of the amplitude is available for each curve. Its disadvantage may be that the diagram becomes confusing and that not every scale can be displayed.

Multiple Chart mode displays each curve in its own area in the display window. This enhances the clarity of the display, but the resolution of the amplitudes may not be as good.

No Axes (Y/t Chart) removes the axes and labeling. Only the curves will be displayed. This provides a high-resolution display.

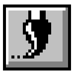
Display Y Unit: the unit of each channel will be displayed in the diagram above the Y-axis. For displays with several charts, Multiple Chart mode may be more suitable.

Grid: Use this command to display, or hide, a grid in the diagram. The Color and Line Style of the grid can be selected in the Window: Colors and Lines box.



Font Style...: Use this command to select font styles to apply to the scales and the displayed units.

This command opens the Windows dialog box for font styles, where you can select the font, and font style (plain, **bold**, or *italics*) as well as the font size. These settings apply to the scales and to the displayed units (if they are to be displayed).



Colors and Lines...: Use this command to modify the colors and line styles for all the elements of the display window. To modify the settings for an object, the object must first be selected from the object list. Depending on the object type, different options are available.

Click the Color button to open the Windows color definition box for the selected object.

To modify the Line Style and Thickness of the traces, select these items from the list first, where they are represented as Input X (X denoting the number of the activated channel).

- You can choose all the colors of the display window elements directly. Press the **right** mouse button inside a display element to open the Color Selection box.
- If the input curve defined for x is not a closed line, you can fade out marks for better display. If that function is activated, all xx samples are marked in the display window. This function is not an average operation. Samples that are not displayed are only just skipped in the display.

Show/Hide/Setup Legend

The Legend function displays the Channel Name and the unit at the left bottom of the window. If the legend is hidden, only the channel numbers are displayed.

The Setup Legend menu function changes the display characteristics of the legend.

- The Font setting changes the font, style and size of the font. These settings determine the height and width of the legend area.
- The Color setting changes the color of the legend text.
- The Unit setting shows or hides the chosen unit after the channel name.

Show/Hide/Setup Header

The Header function shows or hides an additional text area at the top of the display window. You can also use a global string or variables as text. Choose one you have defined in Option: Define Global Strings/Variables menu or select one of the predefined strings or variables. Click with right mouse button in the edit field to open the context menu to select from the available strings/variables.

The Setup Header menu function changes the display characteristics of the legend text.

- The Text menu function allows you to edit the text string of the header.
- The Font setting changes the font, style, and size of the font. These settings determine the height and width of the legend area.
- The Color setting changes the color of the header text.

Waterfall Display (Y/t Chart)

This command switches the Waterfall mode on or off.

Instead of being completely deleted after each block, the traces will be shifted slightly to the upper right, and the trace for the new block will be added to the diagram. As a result, the individual blocks will create a waterfall display of the whole signal.

Waterfalls display **one signal**. If the Waterfall switch is used in a diagram with more than one signal, only the first will be displayed.

Use the Waterfall Setup command to change the shape of the waterfall.

- Curves in Memory: This number determines how many blocks or traces in the waterfall display will remain in the buffer memory for the reconstruction of the display when the window must be redrawn. For example, redrawing is necessary whenever the window has been resized and whenever an overlapping window has been closed.
- Remove Hidden Lines: If this flag is set, the waterfall will be drawn without hidden lines. Removing hidden lines intensifies the 3D effect of the diagram.
- X Shift Offset: Previous curves will be shifted to the right by the value specified.
- Y Shift Offset: Curves will be shifted upwards by the value specified.

The settings in Time Axis change the display of the x axis:

Show Time Axis**:** This button shows or hides the scale at the x-axis.

Mark Time Axis**:** This option shows the following additional information:

- Running Block Number
- Time
- Seconds since Start of Experiment
- Date + Time

Automatic Scaling: The labeling of the axis happens automatically.

Manual Scaling: The labeling is generated by using the settings at Decimals and Tick mark every ... Blocks.

These settings change the properties of the 3-D presentation. You can:

- fade in a Grid,
- change the curves to 3-D-Bars,
- color the walls in additional Colors (Button Box Color),
- show the Bars with Black Frames
- and change the Color of the Shadow of the 3-D-Bars.

  If you choose the 3-D bar display you can use the X Offset and Y Offset settings to control the distance between the bars.

Sonogram Display (Y/t Chart)

The Sonogram mode displays values indicated by different colors. Values are ordered into 10 classes. Each class is assigned a separate color as defined in Sonogram settings.

You can modify the settings of the colors of the displayed values in a wide range.

- Color Range: Declare the color range in which your measured values will be presented.

The slider for start color defines the color for all values lower than or like the lower limit; the end color defines the color for all values larger than or like the upper limit. The limits can be entered in the boxes under the color range. Between these two colors ***ServiceLab*** calculates a matching vignette. The regulators for brightness and saturation allow you more control over the representation of the color-area.

- Range: Declare the interval within which the color-separation of the Sonograms should take place. All values with amplitudes lower than the low border (from:) are displayed in the start color; all values with amplitudes larger than the upper border (until:) are displayed in the color of the right border. To all values within this interval, a matching color value is assigned in accordance with the definition of the color range.

Options

- Stored lines: The declared number of lines is stored internally and the lines are shown again about one line displaced, so that the complete drawing surface can immediately be shown without the need to be re-built for drawing.
- Grey scale: This option switches the representation into the gray scale mode. No colors are shown for the values, but only gray levels.

Export

Copy to Clipboard: Use this command to copy the contents of the window onto the Windows clipboard. The curve that is copied will include scaling information and the background.

You can paste the diagram into other Windows applications or documents, including Paintbrush or Word for Windows, by choosing the appropriate command from the target application menu (usually Paste from the Edit menu).

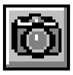
Print: Use this command to print the contents of the current window on the default Windows printer. With a black and white printer, the background color will be ignored, and all objects will be printed in black.

Choose Page Format from the File menu to select additional information to include on the printout, and to specify the page layout and page frames.

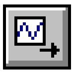
Choose Printer Setup from the File menu to select paper size and paper source, orientation, printer resolution, and other settings for your active printer model.

To activate a different printer model connected to your system, or to install and configure a new printer, choose the Printers option in the Windows Control Panel. Refer to your Windows documentation for further information.

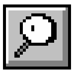
1.7. Survey Functions



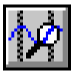
Freeze Display Window: Use this command to freeze the current display window. The measurement is continued, but the display will not be updated until Freeze is turned off. This function is useful for detailed visual analysis with Measuring Cursors, or before zooming is performed.



Continue: Use this command to continue the display of a frozen display window. The display will be updated with current data.

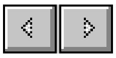


Zoom: Use this command to zoom the display. When the Zoom button is pressed, a zoom cursor appears, and a zoom window can be defined in the diagram area by pressing the **left** mouse button and dragging the cursor. The coordinates of that zoom window will be used as the new boundaries for the axes. You can use the Zoom command multiple times to zoom in on an area in several steps.

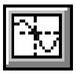


Unzoom: Use this command to unzoom the display and to return the display to the original scaling. The first unzoom command returns the display to the previous zoom step, the second returns it to full display. Continuing a frozen and zoomed display will not unzoom it.

Zooming Options can be specified in the Y/t Chart configuration dialog box. You can constrain zooming to Only X Direction, Only Y Direction, or X and Y Direction.



Move Left, Move Right: If the display window is zoomed using the Zoom function, you can move the displayed sample area using these buttons or menu commands.



Cursor: Use this command to insert two measuring cursors into the diagram and to open a cursor window. The cursors can be positioned by dragging them with the mouse or by using the cursor keys of the keyboard. The cursor window displays the current cursor values. If several traces are drawn in the display window, the cursor window offers a channel selection field.

- The values of the last moved cursor can be inserted into the display window using the `space` button. The values will be shown in-between small borders with an arrow that marks the cursor position. If several traces are drawn in the display window, the cursor window offers a channel selection field.
- If Free Cursor mode is selected from the menu, you can move the cursor around the entire Display window. In the default mode, the cursor is related to the values and moves only on the curve.
- Use the Small Cursor option to display the cursor as a cross hair to get a better view of the cursor position.

- If the Extended Cursor mode is selected from the menu, additional calculated values will be shown.
- If Horizontal Cursors is selected from the menu, two horizontal cursors will be inserted in the display window in addition to the two vertical cursors.
- These values are always displayed in the cursor window.

  Yn the amplitude value for the cursor (n can be 1 or 2)
  tn the time corresponding to the cursor position
  dt the time difference between the two cursors
  f the frequency between the two cursors

- The following additional values are only displayed in the Extended Cursor mode.

  dY difference between the amplitude values
  dY/dt mean slope between the cursor positions
  Min/Max minimum/maximum of the interval between the cursors
  Integral integral of the curve between the cursors
  RMS The **R**oot **M**ean **S**quare value between the two cursors

You can Write Cursor Data that is displayed in the cursor window to a file in **DASYTEC** or **ASCII** Format. You can select the option from the Display Menu, the Function Bar or via an Event Driven Action.

1.8. Options

In this dialog box you can choose the information to be displayed at the actual cursor position.

- Information: Select the kind of Information and the Number of Digits to be displayed.
  - Measured value,
  - Time value and
  - Unit
- Display: This setting specifies how the cursor data is displayed in the Cursor window. Choose between
  - Integral display to calculate and display the integral of the values between both cursors, and
  - Average display to display the arithmetic mean of these values.

You can also define whether the cursor data is written into *Global Variables*. You can write the *Time (X-Value)* and the *Y Value* of both *Cursor positions* (**1** and **2**) into a variable, which can be defined in the edit field at the end of the line.

If you select the *Save selected channels... all channels* option, the cursor data of all used channels are written into global variables. The variable number is

generated using the entered variable number in the edit line **plus** the corresponding channel number. Exceptions are the time data of Cursor 1 and 2 such as the **dt** and **f** values. These data are written only once to the corresponding variable because the values are the same for all channels.

⇨ *If you have written variables first in mode “actual channel“ e.g. channel 3 into variable 7 and now switch to the mode “all channels“, the number of variable the channel 3 is written will shift from 7 to 10! (number of variable* ***7*** *+ number of channel* ***3 = 10****)*

The show or hide option of single channels in the graph has no effect to store the data in the variables until at least one channel is displayed. If all channels are masked of the cursor measurement will stop and so the update of the selected variables will do.

Write Cursor Options: You can select one of the following functions to store cursor data

Cursor 1: Y value of the left Cursor

Cursor 2: Y value of the right Cursor

Cursor 1+2: Y value of the left and right Cursor

all Cursor Data: all data displayed in the Cursor window is written to disk. The extended data is written only if the extended mode is selected.

all Data between Cursor 1 +2: all displayed data is written, selected by the cursor positions.

If the all Channels option is activated, the selected function is used for all displayed channels.

The all Cursor Data mode is only available for the selected channel in the cursor window. All displayed Cursor Data is stored.

Definition of the different data channels is:

Channel 0-5: Y Cursor1, t1, dt, Y Cursor 2, t2, f.

Channel 6-11: dy, Min, Integral, dy/dt, Max, RMS (if extended cursor is activated).

The cursor data can be saved in DASYTEC or in ASCII Format. If the all Data between Cursor 1+2 option is selected, the data blocks are highlighted as triggered data. If the data is to be stored with the actual channel block size, choose the Fill up the Channel Block size option. Click on the ASCII button to change the settings for that option.

Show Cursor Text Strings: Cursor Text Strings, as defined in the Text menu option, are shown on the display. If the function is activated, this is indicated on the menu by a checkmark.

Delete Cursor Text Strings: All previously defined cursor text strings are deleted. To delete or modify a single cursor text string, click on the string area (see Text functions.)

Cursor Data Format: You can choose whether time or unit is shown at the cursor position value. You can also define the number of digits to be displayed.

Print Cursor Data: All displayed cursor data is included in the printer layout.

Show Cursor Data in Layout: If the module is connected to a linked graph object in layout, you can display the cursor data beneath the displayed graph on the layout sheet activating that option. You can also use the usual operations in Layout such as in the display window.

Print Cursor Data on new Page: When printing the actual display window, all displayed cursor data is printed on a separate page.

Copy Cursor Data to Clipboard: When copying the actual display window to the clipboard, all displayed cursor data is integrated with the clipboard layout.

Text Functions

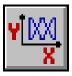
This function allows you to place up to 20 text strings onto the display window for documentation - such as before copying to the clipboard or before printing.

- Activate the Show option in the Text Menu. You can now create a text string. You can freeze the chart, if desired, and you can also edit while the experiment is running.
- Choose Edit New Text String in the Text Menu. Click the **left** mouse button at any place in the window; a separate dialog box window appears where you can enter the text string (up to 50 characters). Press OK and the new text will appear inside the display window. You can change the text position by clicking the **left** mouse button and dragging the text to any place in the window. Up to 20 text strings can be created.
- The appearance of the text string can be configured with the menu functions Font, Color and Frame.
- Print the chart with all text strings now or copy it into the clipboard, freeze and continue the display window or move the text strings and so on....
- You can hide all the text strings by deactivating the menu function Show in the Text Menu. The text strings are not deleted by hiding them.
- You can delete all text strings by choosing the menu function Delete All Text Strings in the Text menu.
- You can delete a specific text string, by double-click-ing the **right** mouse button in the string's rectangle.
- To integrate the cursor data into the display, choose the Cursor function in the Survey Menu. Move the left or right cursor to the position where you want to add the cursor data. Now press the Space Key on your keyboard. The actual cursor data is presented as value pair in the selected cursor channel. You can move the cursor string like other text strings.
- The text strings and string positions are saved with the worksheet.

The Text menu provides functions to change the display characteristics of the text strings in the display window.

- The Font setting changes the font, style, and size of the font. These settings determine the height and width of the edit string rectangle.
- The Color setting changes the color of the edit text, except when the Text in Channel Color setting is activated. In this case, all text strings are displayed in the defined channel color and the Color setting is ignored.
- The Frame menu function surrounds the edit text with a simple frame.
- For a 3D effect, activate the menu function 3D Frame.
- After you activate the Frame function, you can change the Frame Color.

2. X/Y Chart Module



Use this command to insert an** X/Y Chart Display Module **to display blocks of two dependent signals as an X/Y plot.

Input and Output Characteristics

Number of Inputs:	up to 8 pairs
Input Block Size:	any
Number of Outputs:	...
Output Block Size:	...
Max. Number of Modules:	any

Use this module to display signals from one channel plotted against those from a second channel. The input signals will always be processed in complete blocks.

Global Settings

These settings apply to all activated channels.

- Choose Standard Display to show the x/y data plotted as lines
- Choose Polar Display to show the x/y data plotted as an arrow displayed from the (0,0) coordinate point to the (X,Y) coordinate point of the pair of values
- Use the display option Delete Curves after n Blocks to display more the one data block in a window, without deleting previous curves. The display window is reset before displaying the n+1st curve.
- The X Unit can be specified.
- Use logarithmic scaling to scale the Y-axis using a logarithmic scale. Note that the Display From value must be greater than 0.
- The option Copy Inputs to Outputs provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Channel Settings

These settings apply to the selected channel only.

- If you click button X scaling another dialog box opens for specific channel settings.
- If you choose Y scaling another dialog box opens for specific channel settings.

Display Window

The data values from all the module entries will be displayed in a display window tagged with the same module name. The X/Y Chart display window can be opened by double-clicking its icon at the bottom of the desktop.

The display window associated with the X/Y Chart module can display up to 8 pairs of dependent signals as X/Y diagrams. The display style and interactive graphic commands can be chosen from the menu or the Function Bar.

Some of these parameters may also be modified in the display window menu system.

⇨ ***ServiceLab** distinguishes between different types of data: time-dependent, frequency dependent, histogram, continuous, or triggered data. Signals of different types cannot be displayed simultaneously in one X/Y Chart Display Window.*

If your experiment setup yields data signals of different types that you wish to display, use at least one X/Y Chart module for each type.

Double-clicking its icon at the bottom of the desktop can open the X/Y display window.

Some of these parameters may also be modified in the display window menu system. These menus offer several additional display options, including the selection of colors, fonts or line styles. In addition, all the necessary commands for interactive graphical analysis of curves, like zooming or measuring cursors, are available.

2.1. Display Window Menu Options

See Page 9-8 for details of the Display Window Menu options that are common to the Y/t Chart, X/Y Chart and Chart Recorder.

X Axis Scale (X/Y Chart)

This function determines the scaling of the X-axis in an X/Y Chart display window.

All X channels are scaled with the chosen X scaling.

- Use Settings to set the display range of the channel. Choose the Auto option to use the default settings. Choose user defined to change the Scale and String format settings.
- Use Scale to define the number of labeled and blank ticks to display on the axis.
- String format allows you to choose normal, exponential and Engineer format as the displayed number on the axis.
- If you deactivate Display Channel, the curve will not be drawn, and the drawing area for that curve will remain empty (although signals are correctly received at the module input). If you have selected the channel's scale to be displayed, it will still be shown in the display window in the One Chart mode, although none of the traces actually drawn might really refer to it.

If you choose the logarithmic scaling, the Y-axis is scaled using a logarithmic scale. Use this option, for example, to display FFT data channels. Note that the Display From value must be greater than 0.

Cursors

In addition to the functions described on page 9-14, the X/Y Chart Extended Cursor mode displays the following calculated values in the cursor window:

Xn	the X value under cursor n (n can be 1 or 2)
Yn	the X value under cursor n (n can be 1 or 2)
dX	the X difference between the two cursors
dY	the Y difference between the two cursors.

2.2. Write Cursor Data

If the cursor window is active, you can write selected cursor data to disk. Choose Write Options in the Survey menu to select the data to be saved.

2.3. Options Write Cursor

You can choose from one of the following functions:

Cursor 1:	pair of X and Y values of the left Cursor; channel 0 = X1, channel 1 = Y1
Cursor 2:	pair of X and Y values of the right Cursor; channel 0 = X2, channel 1 = Y2
Cursor 1+2:	pair of X and Y values of left and right Cursor; ch 0 = X1, ch 1 = Y1, ch 2 = X2, ch 3 = Y2
all Cursor Data:	all data displayed in the Cursor window is written to disk.

all Data between Cursor 1 +2: All displayed data is written, selected by the cursor positions; channel 0 = all X values, channel 1 = all Y values.

If the all Channels option is activated, the selected function is used for all displayed channels.

2.4. Write all Cursor Data

The mode to write all Cursor Data is only available for the selected channel in the cursor window. All displayed Cursor Data is stored. Definition of the different data channels:

Channel ...	0	1	2	3	4	5
containing values ...	**X Cursor 1**	**Y Cursor 1**	**X Cursor2**	**Y Cursor 2**	**dX=X2-X1**	**dY=Y2-Y1**

Channel ...	6	7	8	9	10
containing values ...	**MinX**	**MaxX**	**MinY**	**MaxY**	**dy/dx**

MinX = Smallest X value between both cursors.
MaxX = Greatest X value between both cursors.
MinY = Smallest Y value between both cursors.
MaxY = Greatest Y value between both cursors.

2.5. Data Formats

The cursor data can be saved in DASYTEC- or in ASCII-Format. If the all Data between Cursor 1+2 option is selected, the data blocks are highlighted as triggered data. If the data is to be stored with the actual channel block size, choose the button Fill up the Channel Blocksize. If the ASCII Format is selected, you can change the ASCII-Format settings by pressing the ASCII button.

3. Chart Recorder Module

***Use this command to insert a** Chart Recorder Module **to display curves of data acquired at a** low speed.*

Input and Output Characteristics

Number of Inputs: up to 16
Input Block Size: any
Number of Outputs: ...
Output Block Size: ...
Max. Number of Modules: any

This module works with complete blocks of data, but continuously shifts the displayed curve from the right to the left. It may be used to display the current value of a signal together with its history.

Module Configuration

Double-clicking on the worksheet module icon can activate the module configuration dialog box.

Global Settings

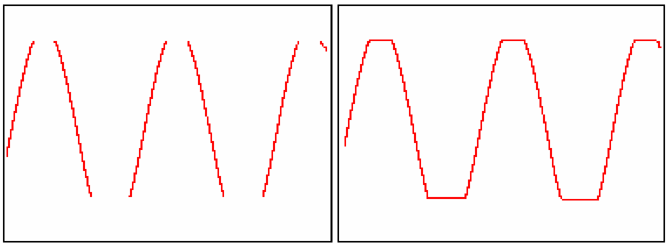
These settings apply to all activated channels.

- Set Zooming Options to constrain how zooming expands the display area:

  X and Y Direction: The display area is expanded exactly as selected with the Zoom cursor.

  Only X Direction: The display area zooms only in the horizontal direction as selected. The scale of the Y-axis remains as defined.

  Only Y Direction: The display area zooms only in the vertical direction as selected. The scale of the X-axis remains as defined.
- Choose the time-scale main unit size with the Display Options. (Display Date or Time Unit)
- Click on the X-Scaling button to modify the Time Scale
- Select whether trigger events are shown as disconnected lines or by connected lines in the Display window
- To modify the Print Options, click on the Print Options Button.



- The picture shows the triggered data curve with gaps, the right representation shows the curve with interconnected lines, making one continuous line
- The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Channel Settings

These settings apply to the selected channel.

- Display Channel activates or deactivates the display of the currently selected channel.
- Click on the Scaling button to modify the Y-Scaling.
- Use the Reference Curve button to open the settings dialog to display an additional Reference Curve in the display window. Use the Reference Curve Module to create a useful Set Point Curve before using this option.

Print Options

You can add additional information onto the printed chart. Activate the function with the Print Option switch.

⇨ *These settings affect the print output. The screen display will not be affected.*

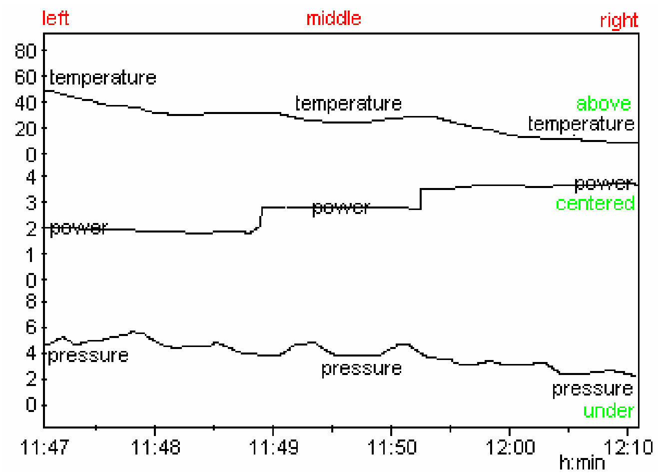
The Print with Channel Color switch assigns the color of the channel to the text (only affects color printers). Text and curves are printed in black with a black and white printer.

Use the Channel name or Free Text radio button to print the channel number near the plotted data curve or in the defined text area.

Other settings control the Text Position: (see the picture below)

The Left, Middle and Right switch show the text at the defined positions. All selections may be used.

The Alignment radio button defines whether the text is placed on (centered), above or below the curve.



3.1. Chart Display Window

The display window associated with the Chart Recorder module can display up to 16 curves simultaneously in one chart.

Double-clicking the icon at the bottom of the desktop to open the Chart Recorder display window. Some of these parameters may also be modified in the separate Display Window Menu System. These menus offer additional display options.

⇨ *The Chart Recorder cannot display frequency dependent data or histogram data, but it is possible to display continuous and triggered data simultaneously in one chart.*

3.2. Display Window Menu Options

See Page 9-8 for details of the Display Window Menu options that are common to the Y/t Chart, X/Y Chart and Chart Recorder. This section describes the options that are specific to the Chart Recorder.

Time Scale

These settings modify the scaling options for the X-axis of the diagram.

All the displayed curves use one joint X-axis. It may be chosen either from the module configuration dialog box of the Chart Recorder module, from the menu or Function Bar of the corresponding Chart Recorder Display Window or by double clicking with the left mouse button on the axis.

These options for scaling the X-axis are available:

- Running Time Scale: This option sets the X axis labeling to seconds, minutes and hours from the start of the measurement. The X-axis will be updated with every shift of the curves in the display.

- Fixed Time Scale: This option fixes the starting point of the X-axis at 0. The labeling will not change during recording.
- Time of Day: Use this option to label the X-axis with the current system time in the format of hh:mm:ss. The labeling will be updated with every shift of the curves in the display.

⇨ *If the measurement has been paused and continued, it will be ignored for the labeling of the Time of Day axis.*

- Display Time: Choose the display time size of the chart recorder. The parameter can be entered in seconds, minutes, hours or days. The maximum display time refers to the data block size, sample rate and the available memory size.
- Time Axis: If Start at Left is selected, the curve will be displayed from the left to the right without shifting until the right boundary is reached. Otherwise the display will start at the right boundary and shift the curve into the window.

Display Function: Search Event

You can use this tool to check recorded curves for special events. Use the Display -> Search menu command of the Chart Recorder display window to enter the settings.

Define the event to search by the signal amplitude and the duration of that level (e.g. search for an event with a level of 5 volts and a maximum duration of 10 seconds).

The unit used for the level depends on the settings of the module that precedes the chart recorder module.

⇨ *The settings are made individually for each channel. You can also use the Search in all Channels setting.*

Settings:

- Channel**:** Select one of the **active** channels to make your settings. Alternatively you can choose All Channels to check all channels for an event. In that case, the next event is always shown independent of channel number.
- Value is..: Define the level (amplitude) for the search. You can select less than, greater than or equal to a defined value
- Tolerance if "equal… +/-: This value defines the maximum valid deviation of the signal from the reference value to be accepted as a valid event. (only if equal to is chosen)
- Length**:** The time interval the event has to last as minimum or maximum to match the condition. You can also use the Any setting to get each event with the defined level without time restriction.

- Pre-/Post Range: This setting limits the displayed values to the defined area (%) before and after the event.

Search Buttons

 Jump to the start of recorded data.

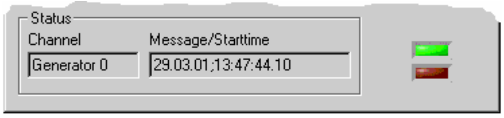
 Search for event (direction is to start).

 Search for event (direction is to end)..

 Jump to the end of recorded data.

Status Area:

The status area shows 4 elements:



- Channel: The channel is shown where the event has occurred.
- Message/Start Time: The start time of an event is shown here. Also error messages are shown here, e.g. “not found”.
- Green Soft-LED: Bright light green signals an event.
- Red Soft-LED: Bright light red signals no event was found. The reason is shown in the message area.

  Possible reasons are:
  - Data buffer full.
  - No data available.

OK Button:

Close the Dialog box. All set parameters are stored until the worksheet is closed and are used again if the dialog is called up again.

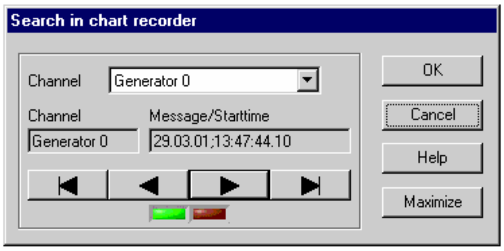
⇨ ***The settings are not stored with the worksheet!!!***

Cancel Button:

Close the Dialog box. All settings are lost. A new start of the Event Search tool will open the default settings.

Minimize Button:

The dialog box is reduced to display just the channel and event information such as the control buttons.



To reset the box to the default size use the **maximize** button.

Survey Functions: Zoom between Cursor

If the Cursor function is active, you can zoom into the curve between the cursor pair. The zooming area is limited to the actual cursor positions.

4. Analog Meter Module

Use this module to display a single data point from a block for up to 16 channels in an analog instrument-like window.

Input and Output Characteristics

Number of Inputs:	16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

Module Configuration

Double-click on the worksheet module icon or anywhere on the corresponding display window to activate the module configuration dialog box.

Global Settings

This setting refers to all activated channels.

The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Channel Settings

The following settings refer to the selected channel.

- Unit: Displays the unit at the bottom of the instrument.
- Lower/Upper Mark: The color of the scale can be adjusted. If this function is active, the area from the end to the mark value is displayed in an additional color, making a simple limit control possible.
- To modify the scale, click on the Scaling button.

- The Analog Meter module displays a **single** value from a data block. The value to be displayed can be selected from the following:

Function	displayed value (of the current block)
Last	the last value
Minimum	the minimum value
Maximum	the maximum value
Mean	the mean value
RMS	the Root Mean Square value

- Activate the Trend parameter to add two arrows to the display of the selected channel. If the displayed value differs from the new value, the color of the arrow changes. If the value is equal, no color change appears.
- Peak Hold: You can add an additional pointer to show the actual Maximum and Minimum value from the start of the experiment. The additional pointers are reset when the experiment is started.
- Use the Speedometer function to display the Analog Meter as a speedometer-type display.
- The Pointer Option switches between a simple line pointer or an arrow styled pointer.
- Pointer Size changes the size of all pointers in the display window.

The buttons at the bottom of the dialog box open dialog boxes to configure the display window.

The format of the numerical values is based on the Country Specific Settings that can be set using the Windows Control Panel.

Scaling

- Use the Channel Bar to select one of the active channels of the module. (The number of channels can't be changed here.)
- Use Settings to set the display range of this channel. Choose the Auto option to use the default settings. Choose User Defined to change the Scale and String format.
- Use Scale to define the number of labeled and blank ticks to be displayed on the axis.
- String format allows you to choose normal, exponential and engineering format as the displayed number on the axis.

Options

You can select from the following options to customize the appearance of the Analog Meter.

- If Show Digital Value is activated, the actual numerical value is displayed at the bottom of the instrument. The number of Digits and Decimals can be specified.

- If more than one channel is activated, you can change the Number of Columns. The arrangement of the display is determined by this setting.
- With Channel Name shows the Channel Name at the top of the instrument.
- With Unit shows or hides the selected unit at the bottom of the instrument.

Colors

You can define the colors of the Analog Meter.

- Color Change: The scaling area above and below the selected limits is shown in the chosen color. If a limit is passed during the experiment the color of the numerical display changes.
- Background: Select the color of the background for the numerical value, the Channel Name and the Unit.
- Text: Select the color of the output of the Channel Name, the Scale and the Value.
- Drawing elements: Select the color of the Pointer and the Trend display.
- Peak Hold: Select the color of the maximum and minimum peak hold.

Font

Select the font used to display the Channel Name and the numerical values in the Analog Meter. You can choose how the font is scaled.

- Click on the Font button to choose the font family, style and size.
- Choose from:

  Single font, fixed to specify the exact font and font size that will be displayed. One font will be used for all elements.

  Single font, automatic to allow the program to automatically resize the font when the display window is resized. One font will be used for all elements.

  Separate Fonts, fixed to specify the exact font and font size that will be displayed. You can specify different font sizes for each element: name, value and scaling.

  Separate Fonts, automatic to allow the program to automatically resize the font when the display window is resized. You can specify different font sizes for each element: name, value and scaling.

Color

You can define the colors of the Analog Meter. Click on one of the elements of the instrument to open the color selection dialog box.

- Color Change: The scaling area above and below the selected limits is shown in the selected color. If values fall below or exceed the specified limits during the experiment, the color of the numerical output switches to the selected color.

- Background: Select the color of the background of the Numerical Value, the channel name and the Unit display.
- Text: Select the color of the output of the channel name, the scale and the value.
- Drawing Elements: Select the color of the pointer and the trend display.
- Peak Hold: Select the color of the maximum and minimum Peak Hold.

Display Window

Double-click on its icon at the bottom of the screen to open the Display Window. Click on the **right** mouse button anywhere in the display window to change color settings.

5. Digital Meter Module

Use this module to display a single data point from a block for up to 16 input signals in an instrument similar to a digital meter.

Input and Output Characteristics

Number of Inputs:	16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

Module Configuration

The module configuration dialog box can be opened by double-clicking on the worksheet module icon or on the display window.

Global Settings

This setting refers to all activated channels.

The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Channel Settings

The following settings affect the selected channel.

- Unit: Displays the unit
- Lower/Upper Mark: The color of the displayed digits can be adjusted. If this function is active, values above or below the set values are displayed in the specified color, making a simple limit control possible.
- The Digital Meter module displays a **single** value from a block of data. The value to be displayed can be selected from the following:

Function	displayed value (of the current block)
Last	the last value
Minimum	the minimum value
Maximum	the maximum value
Mean	the mean value
RMS	the Root Mean Square value

- Activate the Trend parameter to display an arrow in the selected channel if the displayed value differs from the new value. If the value is equal, no arrow is displayed.
- The Display option allows you to switch between several kinds of display usable in for digital data. The value can be displayed as
  - decimal
  - hexadecimal
  - octal
  - binary or
  - ASCII
  - Clock

  Decimal is the most frequently used display. In hexadecimal, octal and binary mode, the fractional digits are truncated and the value is shown with the defined number of digits. In ASCII mode, the ASCII character conforms to the value is shown. If the value is larger than 256, the single digits of the 32 bit number are displayed (one digit represents 8 bits of the 32 bit number; the low Byte is displayed first).

  The Clock Options dosen't display measured values. The time display format is hh:mm:ss.mmm. Use this option to display time information that may have been extracted from a data channel or read from a file or device as a separate data channel.

The buttons at the bottom of the dialog box open dialog boxes to configure the display window.

The format of the numerical values is based on the Country Specific Settings that can be set using the Windows Control Panel.

Options

You can select from the following options to customize the appearance of the Digital Meter.

- Numerical Value: The Number of Digits and number of Decimals can be specified. If the Clock option is selected, the number of digits controls the fraction of seconds.
  - 3 Digits = milliseconds
  - 2 Digits = centiseconds
  - 1 Digit = tenth seconds

- Display: If more than one channel is activated, you can change the Number of Columns. The arrangement of the individual instruments is determined using this setting.
- With Channel Name shows the channel name at the top of the instrument.
- With Unit shows or hides the selected unit at the bottom of the instrument. You can choose whether the unit will appear after the numerical value or at the bottom of each instrument.

Colors

Define the colors of the Digital Meter. Click on one of the elements of the instrument to open the Color Selection dialog box.

- Color change: If values fall below or exceed the specified limits during the experiment, the color of the numerical output switches to the selected color.
- Background: Select the color of the background for the numerical value, the Channel name and the unit.
- Text: Select the color for the numerical output.

Font

Select the font used to display the Channel name and the numerical values in the Digital Meter. You can choose how the font is scaled.

- Click on the Font button to choose the font family, style and size.
- Choose from:

  Single font, fixed to specify the exact font and font size that will be displayed. One font will be used for all elements.

  Single font, automatic to allow the program to automatically resize the font when the display window is resized. One font will be used for all elements.

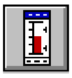
  Separate Fonts, fixed to specify the exact font and font size that will be displayed. You can specify different font sizes for each element: name, value and scaling.

  Separate Fonts, automatic to allow the program to automatically resize the font when the display window is resized. You can specify different font sizes for each element: name, value and scaling.

Display Window

Double-click on its icon to open the Display Window. Click on the **right** Mouse button to change color settings.

6. Bar Graph Module



Use this module to display a single data point from a block for up to 16 input signals in bar graph form.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

Module Configuration

Double-click on the worksheet module icon or on the display window to open the module configuration dialog box.

Global Settings

This setting refers to all activated channels.

The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Channel Settings

The following settings refer to the selected channel.

- Unit: Display the unit at the bottom of the instrument.
- Lower/Upper Mark: The color of the displayed bar can be adjusted. If this function is active, the area above or below the marks is displayed in an additional color, making a simple limit control possible.
- Four different bar graph styles can be selected:

Function	Values will be displayed by
Bar:	a vertical bar.
Triangle:	a small triangle pointing at the scale.
Thermometer:	a vertical bar in the shape of a thermometer.
LED	a bar; divided into segments. Resolution of display is defined by the number of segments and scaling of the bar graph. You can select the number of LED segments to display and their shape (rectangle, rectangle with rounded corners, or as standard round LED).

⇨ *If the **horizontal** direction option is selected, the Thermometer display mode will be disabled.*

- The Bar Graph module displays a single value from a block of data. The value to be displayed can be selected from the following options:

Function	displayed value of the current block
Last:	the last value
Minimum:	the minimum value
Maximum:	the maximum value
Mean:	the mean value
RMS:	the Root Mean Square value

- Activate the Trend parameter to display an arrow in the selected channel when the displayed value differs from the new value. If the value is equal, no arrow is displayed.

The buttons at the bottom of the dialog box open dialog boxes to configure the display window.

The format of the numerical values is based on the Country Specific Settings that can be set using the Windows Control Panel.

Scaling

- Use the Channel Bar to select one of the active channels of the module. (The number of channels can't be changed here.)
- Use Settings to set the display range of this channel. Choose the Auto option to use the default settings. Choose User Defined to change the Scale and String format.
- Use Scale to define the number of labeled and blank ticks to display on the axis.
- String format allows you to choose normal, exponential and engineering format as the displayed number on the axis.

Options

You can select the following options to customize the appearance of the Bar Graph.

- Activate the Show Digital Value function to display the numerical value at the bottom of the instrument. The Number of Digits and number of Decimal places can be specified.

  The format of the numerical values is based on the country-specific settings as specified in the International dialog box of the Windows Control Panel.
- You can specify the scale style of the Bar Graph. You can choose from one scale Per channel, only one scale in front of the First channel or a display completely Without Scaling.

- Alignment: You can display the Bar Graph horizontally or vertically (the default). If horizontal is selected, the bars are displayed horizontally. The Thermometer display mode will be disabled.
- If several instruments are activated in the module you can specify the number of columns to define the placement of the displays beside or on top of each other. The number of lines will be computed from this setting and from the number of activated instruments.
- With Channel Name activates/deactivates the display of the Channel name at the top of each instrument.
- With Unit shows or hides the selected unit at the bottom of the instrument.

Colors

You can define the colors of the Bar Graph.

- Color change: If values fall below or exceed the specified limits during the experiment, the colors of the bar and of the numerical output switch to the selected color.
- Background: Select the background color for the bar graph column, the numerical value and the channel name and for the Bar Graph.
- Text output: Select the colors for the Output of the Channel name, for the Scale, and for the numerical output.
- Drawing elements: Select the colors of the Columns and of the Trend display.

Font

Select the font used to display the Channel Name and the numerical values in the Analog Meter. You can choose how the font is scaled.

Click on the Font button to choose the font family, style and size.

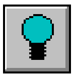
Choose from:

- Single font, fixed to specify the exact font and font size that will be displayed. One font will be used for all elements.
- Single font, automatic to allow the program to automatically resize the font when the display window is resized. One font will be used for all elements.
- Separate Fonts, fixed to specify the exact font and font size that will be displayed. You can specify different font sizes for each element: name, value and scaling.
- Separate Fonts, automatic to allow the program to automatically resize the font when the display window is resized. You can specify different font sizes for each element: name, value and scaling.

Display Window

Double-click on its icon to open the Display Window. Click with the **right** mouse button anywhere in the display window to change color settings.

7. Status Lamp Module



Use this module to display the alternating state of an input signal along with a state-specific alphanumeric string and status light.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

A separate window displays the alternating state of up to **16** input signals along with a state-specific text string and status light. The limit that causes the state change is the numerical value 1.5.

Module Configuration

Double-click on the worksheet module icon or on the display window to activate the module configuration dialog box.

Global Settings

These settings refer to all activated channels.

- The Display Mode Option switches between the standard TTL Input Mode and the Single Bits mode.

7.1. Mode TTL Input

In TTL Input mode each channel gets a Status Lamp (or a selectable Bitmap), which changes depending on the level of Input signal. The limit which causes the state change is the numerical value 1,5.

7.2. Single BitMode s

The state of single bits is displayed. The input value is interpreted as a digital word.

Each channel is displayed as a row of 16 Status Lamps, which are allocated to the respective bit. A maximum matrix of **16x16 bits** may be displayed depending on the number of channels selected.

Optionally, the bit number can be shown in the center of the lamps. In this case, you cannot display additional Status text.

- The Options Button opens the Options Dialog Box to make other global settings.
- Click on the Color button for additional settings:
  - Background Buttons open the Color Menus to set the color for the background of the display window, the symbol area and the channel name pad.
  - Text Buttons open the Color Menus to set the color of the Default Status Symbol (Lamp) or/and Status Text for the Status On/Status Off display. Color of Channel name is also selectable.
  - With buttons Bit On ... and Bit Off... in Bit Number you define the color of the bit numbers displayed in the middle of the Bit Lamps (Only used in Single Bit mode).
- Fonts Button opens the Text Dialog Box to set the Font Type and Size of the text in Status display window.

The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.

Channel Settings

This setting refers to the selected channel.

For each activated channel, the Status Text shows the state of the digital input signal by displaying different lights and alphanumeric strings for low and high states.

- Bitmap...

  To show the Status as a Symbol you can use the Default Symbol (Lamp: ON.BMP and OFF.BMP) or any Bitmaps. Activate this option using the Show Bitmap switch.

  Bitmaps...

  - Display: Stretch Bitmap and Draw bitmap show the Bitmaps adapted to the window frame based on original size. To change the displayed Bitmaps when reaching different levels, make the following settings:
  - Levels: You can define 11 Levels at which to change the displayed Bitmap. Select the Bitmap file using the File name... button. The selected Bitmap file is linked to the actual Level. The name of the linked file is displayed in the bottom line. Define the Threshold level at which the program switches to the next bitmap. This bitmap is displayed until the next threshold is reached. The range at which the bitmap is displayed is shown beside the threshold area.

⇨ *Level 1 has no threshold. The linked Bitmap is shown from -∞* ***until threshold of level 2.*** *The Bitmap for the last level is shown from* ***the last threshold until ∞.***

Options

All settings in the Options dialog apply to all activated channels of this module. You can select the following options to customize the appearance of the Status Lamp display window.

- Display: If more than one instrument is activated in the module, you can change the Number of Columns. The arrangement of the individual instruments within the display window is determined using this setting.
- with Channel Name shows or hides the channel name at the top of the instrument.
- with Status Text shows or hides the status text beside the status symbol.

Colors

You can define the colors of the Status Lamp.

- Background: Select the background color for the text area with the Channel Name.
- Text: Select the color for the Channel name in the text area.
- Status On, Status Off: Select the colors of the default symbol (the lamp) for the On and Off state.

Font

Select the font used to display the channel name and the numerical values in the Status Lamp. You can choose how the font is scaled.

Click on the Font button to choose the font family, style and size.

Choose from:

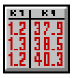
- Single font, fixed to specify the exact font and font size that will be displayed. One font will be used for all elements.
- Single font, automatic to allow the program to automatically resize the font when the display window is resized. One font will be used for all elements.
- Separate Fonts, fixed to specify the exact font and font size that will be displayed. You can specify different font sizes for each element: name, value and scaling.
- Separate Fonts, automatic to allow the program to automatically resize the font when the display window is resized. You can specify different font sizes for each element: name, value and scaling.

Display Window

The data values from all the module entries will be displayed in a display window tagged with the same module name. Open the display window by double-clicking its icon at the bottom of the desktop.

For each channel, the display window contains its channel name, an area for displaying the status string, and the light symbol.

8. List Display Module



Use the** List Display Module **to display the values of its input signals in list form.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	...
Output Block Size:	...
Max. Number of Modules:	any

This module displays numerical data in a table. Data values are updated in blocks; so only a few values of large data blocks are displayed depending on the window size and the selected module data buffer. If a small block size is selected (e.g., 1 or 2), the old list scrolls up and the new values will be added in the list. This module can store **9999** data values/channel.

Module Configuration

Global Settings

These settings refer to all activated channels.

- The Copy Inputs to Outputs option provides the module with one output for each activated input channel. Incoming data is provided unchanged at the output.
- Digits: This display defines the number of characters to be displayed for each data channel. In addition to Font and Font Size, you can set the width of the display window. The text can have a length of 5 up to 20 characters.
- Decimals: Specify the number of decimal places (0 to 5) to be shown for normal measurement values.

Channel Settings

This setting refers to the selected channel. Click Display Channel to show or hide the selected channel.

Options

You can select the following options to customize the appearance of the List display window.

- With Time Channel: Select this switch to display a Time Channel in addition to the list of numerical values in the display window. The time values to be displayed are specified with Time Channel Type.

If the data to be displayed in the List Display module is frequency data (from an FFT module), the Time Channel column is replaced with a Frequency column and displays the actual frequency value, not the time.

- With Unit shows or hides the selected unit below the Channel Name
- Data Samples per Channel specifies the length of the list If this value exceeds the maximum number of values to be displayed, a scroll bar will be shown at the left side of the list box. Use this scroll bar to select the section of the list to be displayed. The maximum memory depth per channel is 9,999.
- String Format: Specify if the measurement value is to be displayed in the Normal Format, the Exponential or the Engineering Format. The Engineering Format is similar to the Exponential representation but displays an exponent of 3 or a multiple.

Display Window

The data from all the module entries will be displayed in the display window (the List Display window) attached to each module and tagged with the same module name. Open the display window by double-clicking its icon at the bottom of the desktop.

Some of these parameters may also be modified in the display window menu system.

The display window associated with the List Display module can display the data of up to 16 channels in one list.

The display style and interactive commands can be chosen from the menu or the Function Bar.

Edit Functions

List to Clipboard

Use this command to copy the contents of the window onto the Windows clipboard. The list that is copied will include scaling information, but not the background.

You can paste the diagram into other Windows applications or documents, including Paintbrush or Word for Windows, by choosing the appropriate command from the target application menu (usually Paste from the Edit menu).

Print

Use this command to print the contents of the current window on the default Windows printer. With a black and white printer, all printing will be black on a white background.

Choose Page Format from the File menu to select additional information to include on the printout, and to specify the page layout and page frames.

Choose Printer Setup from the File menu to select paper size and paper source, orientation, printer resolution, and other settings for your active printer model.

To activate a different printer model connected to your system, or to install and configure a new printer, choose the Printers option in the Windows Control Panel. Refer to your Windows documentation for further information.

Display Functions

Time Channel

A time channel for a data list can be defined in this submenu.

The time can be listed in three different modes:

Function	Displayed Time Value
Time of Day	the current time when the sample was acquired
Measurement Time	the time since the start of the measurement
Sample Number	a continuous numbering of all the lines in the list

The time format is based on the Country Specific Settings which can be set using the Windows Control Panel.

If the data to be displayed in the List Display module is frequency data (from an FFT module), the Time Channel column is replaced with a Frequency column and displays the actual frequency value, not the time.

Freeze

Use this command to freeze the current display window. The measurement is continued, but the display will not be updated until Freeze is turned off. The Continue function unfreezes the display window.

Continue

Use this command to continue the display of a frozen display window. The display will be updated with current data.

Function Bar

The Function Bar contains icons which provide easy access to several functions and options from the display window menus. Just click the icon representing that function. All the commands represented on the Function Bar are also available from the menus.

Display Y Unit

If this flag is set, the unit is displayed underneath the channel name.

Font Style...

You can select the font, font style (plain, **bold**, *italics* and underlined) and the font size. These settings apply to the displayed characters and the title.

Text Color.../Background Color...

This command opens the color selection dialog box. The List module allows you to change the color of the displayed text and lines and the color of the background.

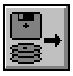
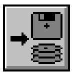
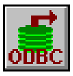
Show Unit

If this flag is set, the unit of each channel will be displayed in the list beneath the channel name.

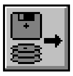
Chapter 10
Files

Chapter 10: Files Module Group

This group consists of modules for reading and writing data.

	Module	Basic version	optional
	Read Data	x	
	Write Data	x	
	Backup Data	x	
	ODBC Input	x	
	ODBC Output	x	

1. Read Data Module



Use this module to read data from disk files of different formats.

Input and Output Characteristics

Number of Inputs:	none
Input Block Size:	none
Number of Outputs:	up to 16 (as defined in the file)
Output Block Size:	any (as defined in the file)
Max. Number of Modules:	any

The Read Data module can read data files in limited number of formats:

- DASYTEC format (extention .DDF)
- IEEE32-bit float values (extention .I32)
- Delimited ASCII characters (extention .ASC)
- Flex4 format (extention .RES or .INT)

The Name button opens the Windows file selection dialog box, where the file to be opened can be selected. For more details, see the Open... command from the File menu.

When a file has been selected, ***ServiceLab*** checks the file and displays the File Description. If it is a DASYTEC file, this description will provide information concerning the date and time of the recording, the number of recorded channels, the sampling rate, etc.

If more than 16 channels have been recorded in the selected file, the Display group box displays which group (of 16 channels each) is currently selected for reading.

You can use global strings to build the file name. You can use more than one string (e.g. `${STRING_001}${STRING_002}`), allowing you to read file names built from more than one part.

If data is read in the DASYTEC format, the following parameters are set in the Read Data box:

- Use Global Sampling Rate: If this option is selected (and the Real Time Output option is active), data will be read according to the global sampling rate. The sampling rate recorded in the file does not affect the reading.
- Real Time Output: If this option is selected, data will be read at the same speed at which it was stored.

If neither of the above items is chosen, data will be read as fast as possible.

- Original Date/Time: If this option is selected, data values will be provided with their recording time and date. This is especially useful in combination with the Chart Recorder and the List Display modules. If you have more than one file selected, the Date/Time from the first file will be used for all the files.

  Data stored in the IEEE 32 Bit format will be read without any accompanying time or sampling rate information. In that case the current worksheet settings will be used.

- Stop at End of File: If this option is activated, the file will be read **only once**. The module symbol will then display **EOF** (End of File), and the experiment will automatically be stopped. If the number of samples in the file is not a multiple of the block size, data samples are skipped at the end of the file. If the file does contain less than one block of data, no samples are read. To repeat the reading process, start the experiment again.

  If this option is **inactive**, the file will be read from the beginning again as soon as its end is reached. To stop the reading process, stop the experiment.

- Action driven Block Output: Depending on an Event Driven Action, the read data is sent to the output **block by block**. This option is especially useful in files that are written with a block length of 1; in this case you can view each single sample of the file.

- Select Show Status Window to choose if a Status Window should be displayed. The window shows the actual file name from which data values are read. During the experiment the name of the actual File and the number of bytes (in %) read from file are displayed.

The Data Format parameter shows whether data samples were stored in standard format (Universal1) or in disk streaming format (Universal0). If an ASCII or IEEE 32 Bit file is selected, the Data Format parameter changes to Number of Channels. Enter the number of channels that are saved in the file.

- If the data to be read is **DASYTEC format with more than 16 channels**, the Data Channels item in the File Header as Text window shows the following entry: `DATA CHANNELS=MUX: x1/x2/x3/x4 ...` where the values of **x1 ...x16** give the number of channels in the several channel groups. You have to select a channel group to read the data of the channels stored in that group.

- If data in the IEEE 32 Bit format is read, the number of channels has to be the correct number of channels that the file has stored. If the number of saved channels is less or more, data of different channels will be mixed.

- If ASCII data is read, an incorrect number of channels will not cause mixed data channels. Larger channel numbers will be ignored and missing channels filled up with the value 0,0.

All lines in the ASCII files that start with a non-digit are interpreted as a header until at least one valid line of data is found. In all following lines, non-digits will be skipped.

- ASCII Format: If the file is an ASCII file you can select ASCII Format Options to define if a time channel exists and how it is to be treated.
- Options: Use Options to select a segment of the file to be read. This function is only available for DASYTEC file types.
- Multi-File: ***ServiceLab*** provides the option to read data from a series of several separate files. All these files share the same name root (between 4 and 7 characters) followed by consecutive numbers automatically assigned by the program.

  Click the Multi-File button to open a dialog box where these and other parameters of this option can be specified. Activate the Read as Multi-File option first to enable any other inputs.

  Note: you can only read DASYTEC format files as a Multi-File.

Read File Section

Use this option of the Read Data module to determine if the complete file or just a section of it should be read. The option applies to all data formats that can be read by ***ServiceLab***.

With the Read Section function activated, only a section of a file is read. The section is defined by an input in a separate window.

- Define the physical unit that is used to identify the section of the file. You can select:
  - Milliseconds
  - Seconds
  - Minutes
  - Hours
  - Days
  - Date/Time
- If the file is selected, the Start Time is displayed beneath the unit selection field.
- Enter the actual range In the fields From: and To:. To enter the time, use the format **HH:MM:SS,uuu** where HH = hours, MM = minutes, SS = seconds, and uuu = fractions of a second.
- If the DASYTEC file format is selected, you can use the Copy option to choose that additional information should be read from the file (Author, Company, Department and/or Title).

Action at End of File

The Action at End of File option is to effect an asynchronous Action that is checking the status of a global variable. You can choose between setting and incrementing a global variable. Additionally, you can select whether the global vari-

able is changed at the end of each file of a multi-file series or only at the end of the last file of a series.

- Activate the Set Strings option to write several global strings with Information about the read file:

  File name → Global String - writes the name of the file into the defined string.

  Date → Global String writes the original Start date of the file into the defined string.

  Time → Global String writes the original Start time of the file into the defined string.

  You must define the number of the string (**1 ... 1000**).

1.1. Read Options

1.1.1 ASCII Format

ASCII Time Channel

If ASCII data values are to be read, the following options are selectable:

- ASCII: Specify whether a time channel exists and if it contains time or date and time data. If not selected, time values are not evaluated, the time channel is skipped and the global time settings are used.
- Time Channel Parameter: If the time channel is not skipped, select Evaluate Time Information to specify the time format. The date format can also be specified.
- Time Channel Mode
  - Continuous Time Data: When starting the measurement, some of the data channels are tested for time information. If the data does not have the same sampling distance (i.e., there are gaps), the experiment is stopped and an error message displayed.
  - Evaluate Each Time Data: This setting forces time data to be evaluated during the acquisition. The output data values are marked as triggered data with a block size of 1. This setting makes sense for files with a time channel that contains date and time information. If you select Original Date/Time, data values will be provided with their recorded time and date. This is especially useful in combination with the Chart Recorder and the List Display modules.

1.1.2 FLEX4 Format Read Options

If the file is an **FLEX4** file you can select FLEX4 Format Options to define the output parameters.

A File Read module can only handle up to 16 channels (=sensors). The Flex4 format is no exception to this. To read more than the first 16 sensors of a file,

multiple File Read modules must be created, and given the same file name to read. Each File Read module determines the sensors to read by setting the Channel Offset entry found at the bottom of the dialog box. Note that this offset starts with 0, so to read the first 16 sensors, set the offset to 0, for the second 16 sensors, set it to 16, and so on. You can, however, set the offset to any number you like; it does not need to be a multiple of 16.

The number of sensors to be read can be entered in the No. of Channels field. Please note that a single File Read module can only read consecutive sensors.

Header

Save the Description string of the Flex4 file header to a ***ServiceLab*** global string. The string can then be used in many ways, including displaying in a layout or writing it to another file.

Output Parameter

Change the Block Size of the File Read module. By default, the ***ServiceLab*** global block size (defined in the Experiment Setup) is used for reading the data from the file. Since the information in the Flex4 files is not blocked, this might lead to trouble if the last few samples do not complete a block, they will be ignored. This cannot happen, of course, when a block size of 1 is selected. It should be checked carefully, however, that the block update rate does not get too high to avoid to big system load. In general, there should not be more than 10 or 20 blocks per second, but the actual rate can only be determined by experiment. If the file size is known (e.g. 10 minutes of data at 25 Hz), a block size should be selected that allows the complete file to be read at a moderate block rate (600 blocks of size 25 at a rate of 1 sec. In our example would fit).

Change the Sample Rate. It is possible to enter a new sample rate for the data. Note that this does not mean that the data is resampled, the data from the file are simply output at a different rate. In general, this should not be necessary.

1.2. Multiple Files

Multi-File Setup

ServiceLab provides the option to read data from a series of several separate files. All these files share the same name root (of between 4 and 7 characters); the remaining characters in the file name (up to 4) are replaced by numbers that will increase by one from file to file. A new file will be read as soon as the specified conditions are fulfilled. Activate the Read as Multi-File option first to enable the other inputs. If this option is not selected, the other options in the box are grayed out and cannot be modified.

File Name Numbering

Specify the number of file name characters that will be reserved for counting the files. Since a file name can only consist of up to 8 characters, this number is limited to 4.

File Chain

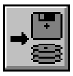
Specify whether files of Only One Series or Different Series are read.

The Original Time switch is only available if Different Series is chosen. When it is activated, the newly read data samples are linked to the older data separated by a space. If the option isn't chosen, new data samples will be linked directly to the old data; all original time information is lost.

File Numbers

- Last File No.: This entry determines the last number to be assigned in the file list. The value allowed here depends on the number of digits specified for File Name Numbering. It will be 9, 99, 999 or 9,999 respectively.
- Stop after Last File: If this switch is set, acquisition will stop completely after the file with the Last File Number was read or if no valid file name has been found to continue Multi-File reading.
- Restart after Last File: This switch can be used to run measurements in a cyclical fashion. If it is activated and the last possible file was read, the list will start again with activated file name. If the switch Restart No. is activated the current restart number is used as first file number. The value allowed here depends on the number of digits specified for File Name Numbering. It will be 9, 99, 999 or 9,999 respectively.
- Select the Pause at end of each file option to automatically stop the reading of the files as soon as the end of file of a file of that Multi-File series is reached.

2. Write Data Module



Use the Write Data Module to store data on disk in files of different formats.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as inputs (if option is activated)
Output Block Size:	none
Max. Number of Modules:	any

When the module configuration dialog box is closed, an error message will be display if there is not **at least 64 KB of free space** on the target disk. ***ServiceLab*** automatically checks to ensure there is **at least 64 KB** free space on the target disk. If that is not the case, an error message will be displayed.

If there is not enough space on the disk to write all the data during measurement, the experiment will be stopped, and a message will notify you.

File Format

Data can be stored in one of the supported file formats. Different settings may be necessary, depending on the selected format. Settings not relevant for the selected file format are dimmed. The default file name in the File Name box automatically has the standard extension of that file format.

The following file formats are currently supported:

- DASYTEC
- IEEE 32 Bit
- Famos
- Remus
- FLEX4
- Signalys
- DAP-Vector
- DIA / DAGO
- DADiSP
- ASCII

For detailed information about these formats, please refer to the list beginning at page 10-11, or to Chapter 5 of the User Guide.

⇨ ***ServiceLab*** can only read data if it was stored in DASYTEC format, ASCII format or in the IEEE 32 format.

Options

The following functions and parameters can also be selected in the dialog box:

- Block/Header Separate: With this option (only with DASYTEC Format) you can choose whether the header is stored in the same file as the data or in another file with the same name but a different extension. When data is stored in different files, the extension of the header file is .DDF. The extension of the file with the data blocks is .DDB.

⇨ ***ServiceLab*** can only re-read this type of data if **both** files are present in the same directory.

- The Append to existing File option allows you to append data values to an existing file without overwriting old data (DASYTEC and IEEE 32 file format only).
- Write Protection: To prevent ***ServiceLab*** from overwriting an existing file name, select the Write Protection option. If the file already exists when the experiment is started, an error message will be displayed. Click the Name button to enter a new file name, or disable Write Protection.
- The Save data every XXX blocks switch increases data security. After XXX blocks are processed, all files are closed and reopened again. This results in more valid data if the system crashes than without this switch. Not utilizing this switch may result in loss of data. This option is not available in all data formats. Some formats always store the data on each block

- File Name --> Global String: Use this switch to specify that the defined data file name is written into a global string. The String No: Entry field defines the string Number. You can choose between Name only or Incl. Path for the contents of the string.
- The Comments button opens a dialog box with an edit area, in which you can insert any comments with a maximum length of 511 characters. Global strings or variables are also allowed. The content of the area, including the contents of the variables and strings, is written into the file header when the file is stored. To enable this option you must activate the Write Comments radio button.

⇨ If space on backup medium is low, the measurement doesn't stop, but a message is displayed. The incoming data are skipped.

File Name

The File box displays the name of the file to be written. To enter or modify it, click the File Name button. The file selection dialog box appears, where the name, the directory and the drive for the file to be saved can be entered. For more details, see the Save command from the File menu. The default file name is `DEFWRITE.*` . The extension will be inserted depending on the selected file format.

If the ...with global string radio button is activated, the file name is built from the inserted global strings. In this case the File Name button is disabled. In the input line you also are allowed to use more than one string (e.g. `${STRING_001}${STRING_002}`), allowing you to build file names from more than one part.

The default directory for the files can be defined in the Options menu.

Copy Inputs to Outputs

The option provides the module with one output for each activated entry. Incoming data is provided unchanged at the output.

Multi-File

ServiceLab provides the option to write data to a series of separate files. Click the Multi-File button to open a dialog box where these and other parameters of this option can be specified.

In the Action module or in a Key action, you can select the Write Data module as receiver. When the Next file action is selected, the next file of the Multi-file sequence is opened to store samples. If Backup is chosen, all existing Multi files are stored to disk in the specified path.

2.1. Multi-File

ServiceLab provides the option to write data to a series of separate files. All these files share the same name root of between 4 and 7 characters; the remaining characters in the file name (up to 4) are replaced by numbers which increase by one from file to file. A new file will be created as soon as the specified conditions are fulfilled.

Click the Multi-File button to specify the parameters for this option. Activate the Write as Multi-File option to define the settings.

File Names and Start Conditions

- File Name Numbering: Specify the number of file name characters that will be reserved for counting the files of the series. Since a file name can consist of up to 8 characters, this number is limited to 4.

*DOS based file systems allows only a **maximum of 2000 files** per folder, even though you are able to entry in this field values up to 10000. If you using such file systems (Win3.11; Windows 95) don't set that value greater than 2000, because operating system will prompt an error message.*

- First File No.: This entry determines the first number to be assigned in the file series. The value allowed depends on the number of digits specified for File Name Numbering. It will be 0, 00, 000 or 0000 respectively.
- Chain File Name Series: If this switch is set, the program will search the specified directory for the file with the highest number from the file name list. The First File No. of the new series will be the next number.

  If this switch is not set, the selected file number will be the first at any experiment start. Existing files will be overwritten.

  The module checks the contents of the chosen directory at load time. A new file is generated right after the highest numbered file with the same file name. Older files will not be overwritten.

Use the Action module or a Key action to select the Write Data module as receiver. While the Next file action is selected, the next file of the Multi-File sequence is opened to store samples. If Backup is chosen, all existing Multi-Files are stored to disk in the specified path

File Switching Conditions

The following settings determine when and how a **new file** is started:

- File Switch Condition: This value determines the number of data blocks that are to be written into each file, and the channel number for which this condition has to be fulfilled. A channel number of **–1** means that the specified number of blocks has to be stored for all the channels.
- Pause before File Switch: If this switch is set, acquisition will pause each time a new file needs to be opened. A dialog box ap-

pears, you can: save the last file as it was written; or have it overwritten; or stop the measurement. If you click Stop Experiment, acquisition will be stopped completely. This is a useful option for series of experiments where you want to confirm each run.

If you click Overwrite or Count up, you must explicitly resume the experiment (for example, by clicking the Function Bar icon).

End Conditions

The following settings determine the end of the Multi Write Data procedure:

- Last File No.: This entry determines the last number to be assigned in the file series. The value allowed depends on the number of digits specified for File Name Numbering. It will be 9, 99, 999 or 9999 respectively.
- Stop after Last File: If this switch is set, acquisition will stop completely after the file with the Last File Number is written.
- Restart after Last File: Use this switch to run measurements in a cyclical fashion. When the last file is written, the series will start again with file number 0. The value allowed depends on the number of digits specified for File Name Numbering. It will be 9, 99, 999 or 9999, respectively.

2.2. File Formats

ASCII

Multiple-channel data can be saved to an ASCII file. The signal values from the channels will fill the columns of a data matrix, where values coming in simultaneously are stored in one line. Each line ends with a **CR/LF** (CHR13/CHR10) character. All the **channel names** appear in the heading of the file.

To modify the default ASCII format:

- Delimiter: Select a TAB or a semicolon as the delimiter between the channels in each line.
- Decimal Character: Select a dot (period) or a comma as the decimal character.
- Header: Store additional information in the file header: the worksheet file name, the current time and date, the block size, the sampling rate and the number of channels.
- Global Strings/Variables: This option is only available if the Header option is activated in Extra Info. To always write Strings/Variables into the Header select the Set Global Strings /. Variables option in the Option menu (Global Strings/Variables).

  You also can select specific Strings or Variables to be written into the header of the file. To select one or more, choose one of the defined

strings/variables by using their number. If the selected number is already marked to be always written into the file header, the radio button is disabled and marked with a checkmark.

Write Readable: global strings and variables are written into the header in the following form:

```
...
${STR_X}=Alphanumerical String (X=1...200)
...
${VAR_X}=String (X=1...200)
...
```

This format can be re-read as ASCII format.

Write As Info: In this mode, global strings and variables are written into the header simply marked as info by a leading “>“ in the following form:

```
...
>Name:Alphanumerical String
...
>Name:String
...
```

The name is the text written into the edit field description at the variable/string definition

- Time Column: Store an additional column with time information for each sample. The following formats are implemented:

		Example
Elapsed Time [hh:mm:ss]	Elapsed time since start of experiment	00:45:34.20
Date Elapsed Time [hh:mm:ss]	Actual date and elapsed time since start of experiment	1.1.1995; 00:45:34.20
Elapsed Time [sec]	Elapsed time in seconds	345.6
Date Elapsed Time [sec]	Actual date and elapsed time in seconds	1.1.1995;345.6
Time [hh:mm:ss]	Actual time	07:30:30.4
Date Time [hh:mm:ss]	Actual date and time	1.1.1995;07:30:30.4

- Decimal Separator You can choose between the general Windows separator, dot or comma or disable the separator completely.

- Decimals: Specify the number of decimals for the numerical ASCII format for each channel
- Type of Input Data: specify whether the input channels contain multiplexed (see Merge/Expand, page 11-9) data.
  - Single Samples: the data is not multiplexed and the input channel contains samples from single channel. Samples are stored using the input channel order, with each channel saved in each line of data (row major order).

    S1C1, S1C2, S1C3, ... S1Cn
    S2C1, S2C2, S2C3, ... S2Cn
    ...
    SmC1, SmC2, SmC3, ... SmCn
    n = number of channels, m = final sample
  - Mixed Samples: the data is multiplexed using Sample mode. You can specify the number of channels that are multiplexed in each input channel. Samples are stored in the following way:

    P 1: S1C1, S2C1, S3C1 ... SnC1
    P 2: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P i: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P 1: SmC1, SmC2, SmC3 ... SmCn
    P 2: SmC1, SmC2, SmC3 ... SmCn
    ...
    P i: SmC1, SmC2, SmC3 ... SmCn

    P = position in Data block, S = sample, C = channel, i = Block Size, n = number of channels, m = final sample
  - Mixed Blocks: the data is multiplexed using Block mode. Samples are stored in the following way:

    P 1: S1C1, S2C1, S3C1 ... SnC1
    P 1: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P 1: SmC1, SmC2, SmC3 ... SmCn
    P 2: S1C1, S2C1, S3C1 ... SnC1
    P 2: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P 2: SmC1, SmC2, SmC3 ... SmCn
    ...
    P i: S1C1, S2C1, S3C1 ... SnC1
    P i: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P i: SmC1, SmC2, SmC3 ... SmCn

    P= position in data block, S = sample, C = channel, i = block size, n= number of channels, m = final sample

Use Number of Channels to select the input channel using the +and - buttons. Then you must define the number of channels, multiplexed to the input channel of the Write Data module. This number has to be the same as the inputs of the merge module, which are bundled into the output channel. The data at the different input channels of the write data module has to be merged in the same way, as blocks or as samples.

⇨ *ASCII format may only be used for data from channels of equal types and sampling rates.* ***Mixed data*** *(mixed Trigger and Histogram data) must be stored in the* DASYTEC *or Signalys formats.*

FLEX4 Format

- Header: The header is stored in the same file as the data itself. You can also use **global strings** or **variables**, as descriptions to be stored in the header of the file.

Options

- Generate automatic file name from date.

  If this option is active, the **file name** will not be taken from the file selection mechanism, but generated from the time of the first data sample in the file according to the document RDTQA-011a. Note that only the pure file name is exchanged, the drive, path, and extension information is taken from the file selected. To check which file name has been generated, use the File Name -> Global String option in the File Write dialog box. The file name generated will then be written to a global string which can e.g. be displayed in a layout.

  The files are named according to the time of the measurements:

  `ymddhhmm.int`

  with y as the year (0 = 2000, 1 = 2001 etc.),
  m is the month (1 – 9 = January – September, a = October, b = November, c = December),
  dd is the day (01 – 31),
  hh is the hour (00 – 23) and
  mm is the minute (00 – 59) at the start of the data set.

- Generate INT file on close.

  If selected, upon closing the *.res file written by the module will be rewound and post processed into a *.int file. The minimum and maximum information for each channel will be collected during the writing process of the *.res file. The file name used will be the same as for the *.res file, but with an extension .INT. If the previous option is active, also the automatically generated file name will be used.

*Note that the post processing process will take some time during which **ServiceLab** is blocked. This should not cause problems if the close operation is initiated by stopping the experiment, but in the case of writing Flex4 multi files this lock may occur during the experiment when a multi file switch occurs.*

- Delete RES file after generation.

  This option deletes the *.res file after performing the post processing operation described before to save disk space. The option is available only if the previous option is active.

- Type of Input Data
- Single Samples: Samples will be stored in sequence of the channels.

  S1K1, S1K2 S1K3 ... S1Kn
  S2K1, S2K2 S2K3 ... S2Kn
  ...
  SmK1, SmK2 SmK3 ... SmKn

  n=number of channels, m=final sample

- Mixed Samples: Data storage depends on the block length. Data is stored in the following way:

P 1:	S1K1, S2K1, S3K1 ... SnK1
P 2:	S2K1, S2K2, S2K3 ... S2Kn
...	
P i	S2K1, S2K2, S2K3 ... S2Kn
	...
P 1	SmK1, SmK2, SmK3 ... SmKn
P 2:	SmK1, SmK2, SmK3 ... SmKn
...	...
P i	SmK1, SmK2, SmK3 ... SmKn

  P=Position in Data block, S=Sample, K=channel, i=Block Size, n=Number of channels, m=final Sample

- Mixed Blocks: Data storage depends on the block length. Data is stored in the following way:

P 1:	S1K1, S2K1, S3K1 ... SnK1
P 1:	S2K1, S2K2, S2K3 ... S2Kn
	...
P 1:	SmK1, SmK2, SmK3 ... SmKn
P 2:	S1K1, S2K1, S3K1 ... SnK1
P 2:	S2K1, S2K2, S2K3 ... S2Kn
	...
P 2:	SmK1, SmK2, SmK3 ... SmKn
...	
P i:	S1K1, S2K1, S3K1 ... SnK1
P i:	S2K1, S2K2, S2K3 ... S2Kn
	...

P i: SmK1, SmK2, SmK3 ... SmKn

P=Position in Data block, S=Sample, K=channel, i=Block Size, n=Number of channels, m=final Sample

- Channel Multiplexing Options.

  If the Type of Input Data is specified as Mixed Samples or Mixed Blocks mode, you can save up to 256 channels in each FLEX4-Format file. For more than 16 channels you must use a Merge module to multiplex multiple channels into one channel.

Select the **Input Channel** using the +and - buttons. Then you must define the number of channels that are multiplexed to the input channel of the Write Data module. This number has to be the **same as the inputs of the** Merge Module, which are bundled into the output channel. This information cannot be retrieved by ***ServiceLab*** automatically. If the information entered here contains a mistake, run time errors or writing of invalid data might occur. The data at the different input channels of the write data module must all **be merged in the same way**, as blocks or as samples.

IEEE 32 Bit

In this format, data is stored as sequences of 4 byte floating-point values without any additional information. This format can only be used for data from one channel, as no channel information is stored. When ***ServiceLab*** reads these data values, the user has to define the number of channels.

The Append to Existing File option allows you to append data values to an existing file without overwriting old data. Please note the restriction that the appended data values must have the identical data types, block length, number of channels, etc.

This format is useful for data exchanges with various analysis programs, since most of these programs can read IEEE 32 bit files. The user must provide the required type and signal information manually.

⇨ *IEEE 32 bit format may only be used for data from channels of equal types and sampling rates.* ***Mixed data*** *(mixed Trigger and Histogram data) must be stored in the* DASYTEC *or Signalys formats.*

Famos

This is the format of the Windows data analysis application ***Famos***.

Famos *format may only be used for data from channels of equal types and sampling rates.* ***Mixed data types and rates*** *must be stored in the* DASYTEC *or Signalys formats.*

Remus

This is the format of the Windows data analysis application ***Remus***.

Remus *format may only be used for data from channels of equal types and sampling rates.* ***Mixed data types and rates*** *must be stored in the* DASYTEC *or Signalys formats.*

Signalys

This is the format of the ***Signalys*** signal analysis program. This format allows mixed type storage and different sampling rates for different channels.

DIA/DAGO

This is the format of the DIA/DAGO signal analysis program.

DIA/DAGO *format may only be used for data from channels of equal types and sampling rates.* ***Mixed data types and rates*** *must be stored in the* DASYTEC *or Signalys formats.*

DADiSP

If this data format is selected the data will be stored in the format of the data acquisition and analysis program **DADiSP**.

Only floating point numbers are saved. The file contains a header and the data. If the data is saved with time information, this time information is stored in seconds. If FFT data is stored, Hz is automatically selected.

DADiSP *format may only be used for data from channels of equal types and sampling rates.* ***Mixed data*** *(mixed Trigger and Histogram data) must be stored in the* DASYTEC *or Signalys formats.*

DAP-Vector Format

If this data format is selected the data will be stored in the format in DAP-Vector Format.

The data are stored as shown in the following example:

vector test = (0, 3000, 6000, 9000, 12000, 15000)

The Options button opens the dialogue box to select the vector name (in example ”test”) and the type of data. You can choose between Integer and Long format.

DASYTEC

This format has been designed specifically for ***ServiceLab***. It allows mixed type storage and different sampling rates for different channels.

The header can either be stored in the same file as the data itself or in another file with a different extension. Global strings or variables that are defined in the program can also be stored in the header of the DDF file. To store a variable or string you must activate the Write to ***ServiceLab*** header option in the Options/Define Global Strings (Variables) settings... menu. Stored variables and strings can be read with the Read Data module. When this option is activated, older strings or variables are overwritten.

The option Append to existing File allows you to append data values to an existing file without overwriting old data. Please note the restriction that the appended data values must have the identical sampling rates, data types, block length, number of channels, etc. If the header differs, the experiment is stopped and an error message is displayed. At experiment start the data types of all channels are marked as triggered data. Thus it is possible to read and display the values in a Chart Recorder as they were stored.

2.2.1 Options Button

Global Strings/Variables

You also can select special Strings or Variables to be written into the header of the data file. To select them choose one of the defined strings/variables by using their number. If the selected number is already marked to be generally written into the file header, the radio button is disabled and marked with a check.

- Type of Input Data: specify whether the input channels contain multiplexed (see Merge/Expand, page 11-9) data.
  - Single Samples: the data is not multiplexed and the input channel contains samples from single channel. Samples are stored using the input channel order, with each channel saved in each line of data (row major order).

    S1C1, S1C2, S1C3, ... S1Cn
    S2C1, S2C2, S2C3, ... S2Cn
    ...
    SmC1, SmC2, SmC3, ... SmCn
    n = number of channels, m = final sample
  - Mixed Samples: the data is multiplexed using Sample mode. You can specify the number of channels that are multiplexed in each input channel. Samples are stored in the following way:

    P 1: S1C1, S2C1, S3C1 ... SnC1
    P 2: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P i: S2C1, S2C2, S2C3 ... S2Cn
    ...
    P 1: SmC1, SmC2, SmC3 ... SmCn
    P 2: SmC1, SmC2, SmC3 ... SmCn
    ...

P i: SmC1, SmC2, SmC3 ... SmCn

P = position in Data block, S = sample, C = channel, i = Block Size, n = number of channels, m = final sample

- Mixed Blocks: the data is multiplexed using Block mode. Samples are stored in the following way:

  P 1: S1C1, S2C1, S3C1 ... SnC1

  P 1: S2C1, S2C2, S2C3 ... S2Cn

  ...

  P 1: SmC1, SmC2, SmC3 ... SmCn

  P 2: S1C1, S2C1, S3C1 ... SnC1

  P 2: S2C1, S2C2, S2C3 ... S2Cn

  ...

  P 2: SmC1, SmC2, SmC3 ... SmCn

  ...

  P i: S1C1, S2C1, S3C1 ... SnC1

  P i: S2C1, S2C2, S2C3 ... S2Cn

  ...

  P i: SmC1, SmC2, SmC3 ... SmCn

  P= position in data block, S = sample, C = channel, i = block size, n= number of channels, m = final sample

If the Type of Input Data is specified as Mixed Samples or Mixed Blocks mode, you can save **up to 256** channels in each file. For more than 16 channels you must use a Merge module to multiplex multiple channels into one channel.

Use Number of Channels to select the input channel using the +and - buttons. Then you must define the number of channels, multiplexed to the input channel of the Write Data module. This number has to be the same as the inputs of the merge module, which are bundled into the output channel. The data at the different input channels of the write data module has to be merged in the same way, as blocks or as samples.

This format allows mixed type storage and different sampling rates for different channels.

Refer to Chapter 5 of the User Guide for additional information about this format.

3. Backup Data Module

Use this module to copy data stored with the Write Data module to diskettes or another hard disk if the storage capacity of the source drive drops below a specified amount.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	1 alarm output
Output Block Size:	same as global block size
Max. Number of Modules:	1

When the module is selected from the Module Bar or the Module menu, this module is displayed in the worksheet as well as an **Icon** at the bottom of the display screen.

The module represents the function in the worksheet and the icon represents the display window containing status information to the current state of the archiving. This window also contains the switch to start the archive procedure.

Module Configuration

Double click the **left** mouse button on the module to open the dialog box.

- Source drive: select the drive to be monitored. Additionally, the monitoring interval can be specified as numerical value with units in Seconds, Minutes or Hours. The shortest possible interval is 10 seconds, the maximum setting is 99 hours and the default setting is 1 minute. The source drive is monitored in the set intervals and the remaining storage capacity is shown in the display window.
- Warning limit: if the storage capacity of the source drive falls below the value set as Warning limit (in Kbytes) a warning will be displayed in the display window of the module and the output of the module is set to TTL High. You can select a value from the list box or you can enter any value in between.
- Destination Disk: specify the target drive to **receive** the data.
- Font: the text display parameters can be set using the Font switch. All text is displayed with specified font and size in the archive window. The size of the window will be automatically adapted based on these settings.

Display window

Double-click with the **left** mouse button to open the **minimized** display window. It shows the following information about the archiving process:

- The Free Storage Space on the source drive is displayed as a percentage of the total disk space. The display value is updated in the set interval.

- The Date and Time of the Last Archiving is displayed. (Before the first archiving, no information is shown here.)
- As soon as the capacity falls below the specified Warning Limit the following Warning Message is displayed in the display window: "Backup."

Archiving

When the capacity of the source drive falls below the specified Warning Limit, the warning message is displayed in the display window. At the same time, the data at the output of the module - normally TTL Low (0V) - changes to TTL High (5V). An alarm action can be initiated by the output of the module, for example, using the Action module to automatically initiate the backup operation or to display a message in the message window.

An archive procedure can be initiated by a mouse click on the Backup switch in the display window. During this procedure all Save Data modules contained in the worksheet are requested to write their measurement values files onto the specified Destination Disk.

- In Normal mode of saving data, the current file is closed and copied to the target drive. The file is deleted from the source drive after it is copied and a new data file is created (including current header data).
- In Multi-File mode, the current file is retained. Any multi-files present are copied to the target drive and then deleted from the source drive.

While copying, the state of the archive procedure is indicated in a status window (the copied amount of data as a percentage of the total).

If the storage capacity of the target diskette is insufficient for the file size, the operator is instructed to insert a new diskette, and the file is split onto 2 or more diskettes. Use the FILEKIT.EXE program (see below) to merge these files together on the hard disk.

Error Messages, Causes, And Remedies

- **No diskette** in target drive (Windows error message): insert a diskette into the target drive and confirm the dialog box. A new write attempt is made. Abort will prematurely terminate the archive procedure.
- The file to be copied exceeds the available storage capacity of the target drive (***ServiceLab*** error message): a ***ServiceLab*** message instructs you to change the storage media. After confirmation, the archive procedure continues.
- While copying to the target drive, the **diskette** is **removed** from the drive (Windows error message): After confirming the message, a new write attempt is made. Abort will prematurely terminate the archive procedure.
- **System error**: Read error on the designated drive (Windows error message): the diskette is not formatted or it is write-protected if this error message is displayed despite a correctly inserted diskette. The archive procedure must be canceled and the error must be corrected.

Before starting an archiving procedure, make sure that the archive diskettes

- *are formatted,*
- *are not write-protected,*
- *contain no old data files.*

The FILEKIT.EXE Program

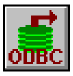
As stated above, files exceeding the storage capacity of the target drive will be split and distributed onto several diskettes. These files can be merged together to a large data file using the FILEKIT.EXE program (in the ***ServiceLab*** directory).

The data file to be merged is selected via the File / Open file menu item.

After confirming the inquiry, the first diskette is read and its contents stored on the target drive. Subsequently, the user is asked to insert the following diskette(s). An additional utility file with the extension *.INF containing information for the copy program is stored on the second and the following diskettes.

The copy procedure is terminated if an error should occur.

4. ODBC Input Module



*The **ODBC Input** module is used for the exchange of information with databases. The content of database table fields are written into global strings and/or variables on an **Action**.*

Input and Output Characteristics

The module is used to set the parameter values for the data exchange with ODBC data sources. The contents of the data source tables are written into global strings/variables.

Module Settings

- Name**:** The name of the data source must be defined here. Use the Search**...** button to show a list of the available ODBC data sources, from which a selection can be made.
- Table: The desired table can be selected from the database. To display all available tables use the Search**...** button.
- If a User Name and a Password are required to the access the database, these can be defined. Otherwise, these entries can remain empty
- Record**:** You can select the data record with the Insert button.

  To display all available data records use the Search**...** button.

  Expressions of the type *field name + relational operand + constant* are allowed. That can be connected through AND or OR. ***A constant can be also a global variable or a global string (use ${STR_xx}).*** A string-constant must be included in simple quotes even if it is a global string.

Examples:

Id = ${VAR_56}

VALUE1 > 5.0 AND TEXT1 = ` ${STR_2} `

If the condition of search is fulfilled for more than one record, all records with which the condition is met are modified.

- Field relationship:

  In the Field Relationship list, the connections of the data fields are listed with the corresponding global strings and variables.

  The Get Field button lists all available data fields in the table. Existing field-assignments stay with it. If no field-list is available a message is shown.

  To select an entry to modify, click on the list. Name and Variable is shown in the input-fields.

  In the Variable field, a global string or a global variable can be selected with a right click. Also an entry can be entered manually. The input of Str_x or Var_x is sufficient.

  With Add, the current entry is adopted from Name and Variable into the list. If Name already exists as an entry for the field, it is used; otherwise a new entry is generated.

  Note: the entry is also used if the Variable field loses the input-focus. Separately clicking the Add button is usually not necessary.

  Use Delete to remove the current entry from the list.

5. ODBC Output Module

The ODBC Output module is used to exchange of information with databases. The content of global strings and/or variables is written on an action into the fields of a table in a database

Input and Output Characteristics

The module is used to set the parameter values for the data exchange with ODBC data sources. The contents of global strings/variables are written to the database.

Module Settings

- Name: The name of the data source must be defined here. Use the Search... button to show a list of the available ODBC data sources, from which a selection can be made.
- Table : The desired table can be selected from the database. To display all available tables use the Search... button.

  If a User Name and a Password are required to the access the database, these can be defined. Otherwise, these entries can remain empty.

- Record

  You can select the data record with the Insert button.

  To display all available data records use the Search... button.

  Expressions of the type *field name + relational operand + constant* are allowed. That can be connected through AND or OR. ***A constant can be also a global variable or a global string (use ${STR_xx}).*** A string-constant must be included in simple quotes even if it is a global string.

  Examples:

  Id = ${VAR_56}

  VALUE1 > 5.0 AND TEXT1 = ` ${STR_2} `

  If the condition of search is fulfilled for more than one record, all records with which the condition is met are modified.

- Field relationship

  In the Field Relationship list, the connections of the data fields are listed with the corresponding global strings and variables.

  The Get Field button lists all available data fields in the table. Existing field-assignments stay with it. If no field-list is available a message is shown.

  To select an entry to modify, click on the list. Name and Variable is shown in the input fields.

  In the Variable field, a global string or a global variable can be selected with a right click. Also an entry can be entered manually. The input of Str_x or Var_x is sufficient.

  With Add, the current entry is adopted from Name and Variable into the list. If Name already exists as an entry for the field, it is used; otherwise a new entry is generated.

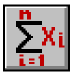
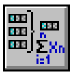
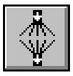
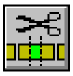
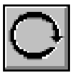
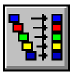
*The entry is also used if the **Variable** field loses the input-focus. Separately clicking the **Add** button is usually not necessary.*

Use Delete to remove the current entry from the list.

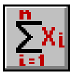
Chapter 11
Data Reduction

Chapter 11: Data Reduction Module Group

This group consists of modules for data reduction.

	Module	Basic version	optional
	**Average**	x	
	**Block Average**	x	
	**Separate**	x	
	**Merge/Expand**	x	
	**Cut Out**	x	
	**Time Slice**		x
	**Circular Buffer**	x	
	**Shift Register**		x

1. Average Module



Use this module to calculate different average values of input signals.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The type of average and the number of samples to average can be specified in the module configuration dialog box:

Running values can be reset during an experiment using Event Driven Actions.

1.1. Options

- If the Restart after ... values option is chosen the calculated value will be reset when the defined number of samples is reached. Calculation of the average starts over.
- The Restart after Data Hole option causes the module to reset if there is a gap between two samples that is larger than the sampling distance. The calculation of the average will start again. The values received until this time will not have an effect on the new average.

1.2. Arithmetic Mean

- Block: The result of this function is one value for each block of n samples, where n is the defined number of samples to average. This value equals the arithmetic mean of the block. This function performs a data reduction with a factor n. Example: Average with 3 samples

  Using the data (a1, b1, c1, a2, b2, c2....) the average (m) is calculated as follows:

  ```
  m1 = (a1 + b1 + c1) / 3
  m2 = (a2 + b2 + c2) / 3
  m3 = (a3 + b3 + c3) / 3
  m4 = (a4 + b4 + c4) / 3
  ...
  ```
- Running: This function calculates the running average over n samples. The start segment contains the mean of the first data sample. The number of

output samples equals the number of input samples. Example: Average with 3 samples

Using the data (a1, a2, a3, a4, a5...) the average (m) is calculated as follows:

m1 = (a1 + a2 + a3) / 3
m2 = (a2 + a3 + a4) / 3
m3 = (a3 + a4 + a5) / 3
m4 = (a4 + a5 + a6) / 3
...

- Summing: For each sample, this function calculates the mean value of all the previous data. The number of output samples equals the number of input samples. For example, using the data (e1, e2, e3, e4, e5, ...) the average (a1; a2, a3 ....) is calculated as follows:

  a1 = e1
  a2 = (e1 + e2) / 2
  a3 = (e1 + e2 + e3) / 3
  a4 = (e1 + e2 + e3 + e4) / 4
  a5 = (e1 + e2 + e3 + e4 + e5) / 5
  a6 = (e1 + e2 + e3 + e4 + e5 + a6) / 6
  ...

- Summing with restart after (x) values: Example: x=3

  a1 = e1
  a2 = (e1 + e2) / 2
  a3 = (e1 + e2 + e3) / 3
  a4 = e4
  a5 = (e4 + e5) / 2
  a6 = (e4 + e5 + e6) / 3
  …

1.3. Quadratic Mean

- Block: The result of this function is one value for each block of n samples, where n is the defined number of samples to average. This value equals the quadratic mean of the block. This function performs a data reduction with a factor n. Example: average with 3 samples

  Using the data (a1, b1, c1, a2, b2, c2) the average (m) is calculated as follows:

$$m_1 = \sqrt{\frac{1}{3}(a_1{}^2 + b_1{}^2 + c_1{}^2)}$$

$$m_2 = \sqrt{\frac{1}{3}(a_2{}^2 + b_2{}^2 + c_2{}^2)}$$

$$m_3 = \sqrt{\frac{1}{3}(a_3{}^2 + b_3{}^2 + c_3{}^2)}$$

...

- Running: This function calculates the running average over n samples. The start segment contains the mean of the first data sample. The number of output samples equals the number of input samples. Example: Average with 3 samples

  Using the data (a1, a2, a3, a4, a5...) the average (m) is calculated as follows:

$$m_1 = \sqrt{\frac{1}{3}(a_1{}^2 + a_2{}^2 + a_3{}^2)}$$

$$m_2 = \sqrt{\frac{1}{3}(a_2{}^2 + a_3{}^2 + a_4{}^2)}$$

$$m_3 = \sqrt{\frac{1}{3}(a_3{}^2 + a_4{}^2 + a_5{}^2)}$$

...

- Summing: For each sample, this function calculates the mean value of all the previous data. The number of output samples equals the number of input samples. Example: Average with 3 samples

  Using the data (a1, a2, a3, a4, a5...) the average (m) is calculated as follows:

$$m_1 = \sqrt{\frac{1}{3}(a_1{}^2 + a_2{}^2 + a_3{}^2)}$$

$$m_2 = \sqrt{\frac{1}{3}(m_1{}^2 + a_2{}^2 + a_3{}^2)}$$

$$m_3 = \sqrt{\frac{1}{3}(m_1{}^2 + m_2{}^2 + a_3{}^2)}$$

$$m_4 = \sqrt{\frac{1}{3}(m_2{}^2 + m_3{}^2 + a_4{}^2)}$$

$$m_5 = \sqrt{\frac{1}{3}(m_3{}^2 + m_4{}^2 + a_5{}^2)}$$

...

1.4. Median

- If the number of samples is uneven, the result of this function is the value of the middle sample of the size-ordered series of the defined number of received samples. If the number is even, the arithmetic mean of the both middle values is used for the result of the function.

- Block: The result is one median for each block of samples, defined in Average Samples (Sum of n values divided by n). This function performs a data reduction with a factor n. Use Change Block Length to change the output block length to the desired value.

  Example 1: Median with 5 samples (uneven number)

  Using the data (a1, b1, c1, d1, e1 and a2, b2, c2, d2, e2 and so on) are sort in ascending order. The median m is the value in the middle:

  a1 < b1 < e1 < c1 < d1 => m1 = e1
  a2 < e2 < b2 < c2 < d2 => m2 = b2
  e3 < b3 < a3 < c3 < d3 => m3 = a3
  ....

  Example 2: Median with 6 samples (even number)

  Using the data (a1, b1, c1, d1, e1, f1 and a2, b2, c2, d2, e2, f2 and so on) sorted in ascending order, the median m is the arithmetic mean of the two values in the middle:

  a1 < b1 < e1 < c1 < d1 < f1 => m1 = (e1 + c1)/2
  a2 < e2 < b2 <f2 < c2 < d2 => m2 = (b2 + f2)/2
  e3 < b3 < a3 < c3 < f3 < d3 => m3 = (a3 + c3)/2
  ....

- Running: In this function the median for each sample with the previous number of data, defined in Average Samples, is calculated. Each new sample gets a new median.

  Example 1: Median with 5 samples (uneven number)

  Using the data (a, b, c, d, e, and b, c, d, e, f, and so on) sorted in ascending order the median m is the value in the middle:

  a < b < e < c < d ⇒ m1 = e
  b < e < c <d < f ⇒ m2 = c
  g < e < c <d < f ⇒ m3 = c
  g < e <d < f < h ⇒ m4 = d
  ....

  Example 2: Median with 6 samples (even number)

  Using the data (a, b, c, d, e, f, and b, c, d, e, f, g, and so on) sorted in ascending order the median m is the arithmetic mean of the two values in the middle:

  a < b < e < c < d < f ⇒ m1 = (e + c)/2
  b < e < c < d < g < f ⇒ m2 = (c + d)/2
  e < h < c < d < g < f ⇒ m3 = (c + d)/2
  e < h < d < g < f < i ⇒ m4 = (d + g)/2
  ....

- Exponential Weighted Mean: With this function you compute the (running) mean with the following formula:

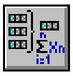
  s (Tau, n) = sqrt (exp (-k) * sqr (s (Tau, n-1)) + k * sqr (x(n))),

where n is the sample number, x(n) is the sample at sample number n, k is the sample distance divided by Tau, and Tau is the specified time constant.

1.5. Options

- If the Restart after ... values option is chosen the calculated value will be reset when the defined number of samples is reached. Calculation of the average starts over.
- The Restart after Data Hole option causes the module to reset if there is a gap between two samples that is larger than the sampling distance. The calculation of the average will start again. The values received up to this time don't have an effect on the new average.

2. Block Average Module



Use this module to calculate the block average, maximum or minimum of its input signals.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any, but fixed
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	any

The Average function calculates the arithmetic means of blocks. The output will always represent the mean value of the different blocks. In contrast with Average, this module builds the mean with the value **n** of the consecutive blocks, not with consecutive values. The Peak Hold function calculates the Minimum/Maximum at each position **n** in block depending on the value of the incoming blocks at this position.

The following averages are provided:

- Single Values: Each output block represents the mean of the specified number of input blocks (see example above).

The number of output blocks will be lower than the number of input blocks.

The Average Samples, 'Restart after... Samples´and 'Time constant´parameters can also be defined using Global Variables. The variables are only checked at the start of experiment. They cannot be changed while measurement is running.

Example: Block size 4, Average 3 Blocks, Single Values

With the Input data blocks (a, b c and d, e, f) with a size of 4 (1 up to 4) the Output data blocks (g and h) are calculated as follows:

$g1 = (a1 + b1 + c1) / 3$ $h1 = (d1 + e1 + f1) / 3$
$g2 = (a2 + b2 + c2) / 3$ $h2 = (d2 + e2 + f2) / 3$
$g3 = (a3 + b3 + c3) / 3$ $h3 = (d3 + e3 + f3) / 3$
$g4 = (a4 + b4 + c4) / 3$ $h4 = (d4 + e4 + f4) / 3$ ... .

- Running: This function recalculates the running mean for each input block. The output block always represents the current block mean of all the previous input blocks. Example: Block size 4, Running average

With the Input data blocks (a, b and c) with a size of 4 (1 up to 4) the Output data blocks (e, f and g) are calculated as follows:

$e1 = a1$ $f1 = (e1 + b1) / 2$ $g1 = (e1 + f1 + c1) / 3$
$e2 = a2$ $f2 = (e2 + b2) / 2$ $g2 = (e2 + f2 + c2) / 3$
$e3 = a3$ $f3 = (e3 + b3) / 2$ $g3 = (e3 + f3 + c3) / 3$
$e4 = a4$ $f4 = (e4 + b4) / 2$ $g4 = (e4 + f4 + c4) / 3$ ...

- Running with Restart: This function is similar to the running average, except that a reset will be performed after *n* blocks, where *n* is the entered number of blocks. Example: Block size 4, Running average with Restart after 3 blocks

With the Input data blocks (a, b, c, d and e) with a size of 4 (1 up to 4) the Output data blocks (g, h, k and 1) are calculated as follows:

$g1=a1$ $h1=(g1+b1)/2$ $i1=(g1+h1+c1)/3$ $k1= d1$ $l1=(k1+e4)/2$
$g2=a2$ $h2=(g2+b2)/2$ $i2=(g2+h2+c2)/3$ $k2=d2$ $l2=(k2+e4)/2$
$g3=a3$ $h3=(g3+b3)/2$ $i3=(g3+h3+c3)/3$ $k3=d3$ $l3=(k3+e4)/2$
$g4=a4$ $h4=(g4+b4)/2$ $i4=(g4+h4+c4)/3$ $k4=d4$ $l4=(k4+e4)/2$ ... and so on

2.1. Peak Hold

- Single Values: Each output block contains the Maxima/Minima of the **x** input blocks

⇨ *The number of output blocks will be lower than the number of input blocks.*

Example: Block size 4, Peak Hold Maximum of 3 blocks, Single Values

With the Input data blocks (a, b c and d, e, f) with a size of 4 (1 up to 4) the Output data blocks (g and h) are calculated as follows:

$a1 < b1 > c1 \Rightarrow g1 = b1$ $d1 > e1 > f1 \Rightarrow h1 = d1$
$a2 > b2 > c2 \Rightarrow g2 = a2$ $d2 > e2 > f2 \Rightarrow h2 = d2$
$a3 < b3 < c3 \Rightarrow g3 = c3$ $d3 > e3 > f3 \Rightarrow h3 = d3$
$a4 > b4 > c4 \Rightarrow g4 = a4$ $d4 < e4 > f4 \Rightarrow h4 = e4$ ...

- Running: This function creates an output block containing the minima /maxima of the specific sample position of all received data blocks. Example: Block size 4, Peak Hold Maximum, Running

With the Input data blocks (a, b and c) with a size of 4 (1 up to 4) the Output data blocks (e, f and g) are calculated as follows:

$a1 < b1 > c1 \Rightarrow e1 = a1 \quad f1 = b \quad g1 = b1$
$a2 > b2 > c2 \Rightarrow e2 = a2 \quad f2 = a2 \quad g2 = a2$
$a3 < b3 < c3 \Rightarrow e3 = a3 \quad f3 = b3 \quad g3 = c3$
$a4 > b4 > c4 \Rightarrow e4 = a4 \quad f4 = a4 \quad g4 = a4$ ...

- Running with Restart: This function creates an output block containing the minima /maxima of the specific sample position of the received data blocks. Reaching **x** blocks the values are chopped and replaced with the minima/maxima of the new blocks and cycle restarts. Example: Block size 4, Peak Hold Maximum, Running with Restart after 3 blocks

  With the Input data blocks (a, b, c and d) with a size of 4 (1 up to 4) the output blocks (e, f, g and h) are calculated as follows:

  $a1 < b1 > c1 > d1 \Rightarrow e1 = a1 \quad f1 = b1 \quad g1 = b1 \quad h1 = d1$
  $a2 > b2 > c2 = d2 \Rightarrow e2 = a2 \quad f2 = a2 \quad g2 = a2 \quad h2 = d2$
  $a3 < b3 < c3 > d3 \Rightarrow e3 = a3 \quad f3 = b3 \quad g3 = c3 \quad h3 = d3$
  $a4 > b4 > c4 > d4 \Rightarrow e4 = a4 \quad f4 = a4 \quad g4 = a4 \quad h4 = d4$ ...

⇨ *Running values can be reset during an experiment using* Event Driven Actions.

3. Separate Module

Use this module to reduce data by skipping the specified number of blocks or samples.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input or specified block size
Max. Number of Modules:	any

This module achieves data reduction

- by skipping an initial number of samples or blocks,
- then repeatedly passing one sample or block to the connected modules,
- then skipping a number of samples or blocks again.

Behavior at Start of Experiment

At the start of the experiment the specified number of samples or blocks (Ignore ... once) is skipped once. The next sample or block will be passed to the

connected modules. The maximum number is 32,000. If a greater number is inserted, it will be reduced to 32,000.

Use this function to perform an initial skip.

Behavior while Experiment is Running

After one sample (or block) has been passed to the module output, the number of samples (or blocks) specified under Ignore ... is read in but not passed to the connected modules.

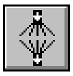
The next sample (or block) is passed again, then the defined amount of data is ignored, etc.

The Output Block Size can be set from 1 to 8,192 if the data reduction is based on samples and not on data blocks.

This module is very useful if you need channels with high and low acquisition rates in one worksheet. Most drivers only support equal sampling rates for all channels; this module can easily perform the necessary data reduction for the slow channels.

⇨ *You can also use Global Variables to define the number of samples. The variable is read each time a mesurement starts.*

4. Merge/Expand Module



Use this module to sequentially combine different data channels into one data channel or to distribute the values of one data channel to up to 16 channels.

Input and Output Characteristics

Number of Inputs:	up to 16 or 1
Input Block Size:	any
Number of Outputs:	1 or more
Output Block Size:	same as input
Max. Number of Modules:	any

Since this module provides two basic operations, you must first select the function type when you install the module.

- Merge: up to 16 channels can be multiplexed onto one channel. Start time, block size, and acquisition rate of all channels must be the same. The number of input channels and the multiplex factor are set using the Channel Bar. The block size of the generated channel and the sampling rate is multiplied by the number of channels

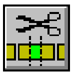
- Expand: one channel is distributed to the number of channels specified by using the Channel Bar. The sampling rate of the output channels is divided by the number of channels.

Use this module to route a large amount of data via one channel. The data can also be processed partially if a Merge module is inserted at the beginning of the channel and a Expand module at the end. Thus the worksheet can be simplified to a large extent.

When used in combination with the Write Data module, this module allows you to store more than 16 channels in one file.

Use the option mode to select between merging/expanding data as blocks or as single samples.

5. Cut Out Module



Use this module to specify a range of values to be extracted unchanged from a data block and routed to the output. The remaining values are set to 0.

One module can process up to 16 data channels with different settings. Use the Channel Bar to specify the number of channels and the channel to be set (selected channel).

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as input
Output Block Size:	same as input
Max. Number of Modules:	any

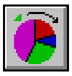
Use Extraction to specify the values for each channel which should be passed on unchanged to the output. All other values within the data block are set to **0**.

If the limits are set to a size exceeding the block size of the data channel, the data is passed on without any modifications.

Example: global block size: 512
data from sample no. 10 through 500
→ the values 1 to 9 are set to 0;
the values 10 to 500 are passed on unchanged;
the values 501 to 512 are set to 0 again.

This function can be used to extract only certain frequency parts of an FFT signal and pass those on for display or further processing.

6. Time Slice Module (optional)



Use this module to combine signal segments from different channels using a defined time schedule.

Since this module provides two basic operating modes, you must first select the function type when you install the module.

- Time Controlled Multiplexer (Time Slice): This module can combine signal segments from different channels by a defined time schedule. Use the Action Module to modify the schedule.
- Amplitude Controlled Multiplexer: This module can combine signal segments from different channels by a defined signal.

In the TTL Controlled Multiplexer mode you can change the parameters using the Action Module. This option is not available in the Amplitude Controlled Multiplexer mode.

6.1. Time Controlled Multiplexer

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	1
Output Block Size:	same as input block size
Max. Number of Modules:	any

The Time Slice module can be used to combine streams of different signals from several input channels according to the defined time slice.

Independent of the number of inputs, the module generates only one output signal, which consists of signal segments taken consecutively from the activated input channels. The first segment is always taken from module entry **0**, the second from module entry **1**, and so forth.

The size of these segments can be specified for each individual input channel in the module configuration dialog box. Their duration (or length) can be defined either as a period of time or as a number of blocks.

After one segment of the specified size from each activated input channel has been output, the first cycle is completed. The Restart at the End of the Cycle flag then determines the output signal:

- If this flag is set, another cycle will start beginning with a segment from channel 0.
- If this flag is not set, the signal from the last activated channel will be output further.

Use the Action module to change the settings using Event Driven Actions. You can switch to the next or previous channel and reset or set output value depending on a specific condition.

6.2. Amplitude Controlled Multiplexer

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	1
Output Block Size:	same as input block size
Max. Number of Modules:	any

The Time Slice module can be used to combine streams of different signals from several input channels according to a defined signal slice.

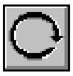
Independent of the number of inputs, the module generates only one output signal, which consists of signal segments taken consecutively from the activated input channels. Activation of the input channel depends on the signal at input **X** of the module.

The kind of signal can be specified in the module configuration dialog box.

- Edge Controlled Increment: on detecting the rising edge of a TTL signal, the module switches to the next channel. On reaching the last channel, a new cycle will start, beginning with a segment from channel **0**.
- Edge Controlled Decrement: on detecting the rising edge of TTL signal, the module switches to the previous channel. On reaching the last channel, a new cycle will start, beginning with a segment from channel **0**.
- Amplitude Controlled: The amplitude of the control signal at input **X** is rounded to an integer that describes the number of the next actual channel. At overflow (amplitude > max. number of channels) the last channel will set. At underflow (amplitude $\leq$ 0) the first channel will be used. Since there is always a useful value in this mode, the Action module cannot be used.

You can use Event Driven Actions to switch to the next or the previous channel and reset or set the output value depending on a specific condition (cannot be used in Amplitude Controlled mode).

7. Circular Buffer Module



Use this module to save data into a buffer for a defined time interval and output it to the module outputs via an Event Driven Action.

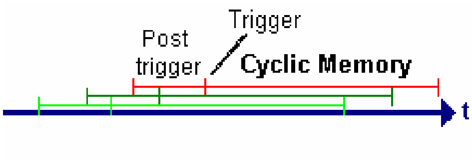
Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as input
Output Block Size:	---
Max. Number of Modules:	any

The Time Interval setting defines the length of time saved into the circular buffer. Samples in the buffer are refreshed at each new measurement cycle, so the oldest values are flushed and the newly received data is added.

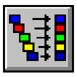
An Event Driven Action will cause the complete contents of the buffer to be output, using the global block size; otherwise the output has no value.

The Post Trigger option allows you to include Samples that are received at the module input while the event has happened.



The Buffer Status ->Global Variable option writes the actual status of the circular buffer in a global variable.

8. Shift Register Module (optional)



*Use this module **to store data, one point at a time** – controlled by a trigger, **into a temporary register**, and outputs a block repeatedly.*

Input and Output Characteristics

Number of Inputs:	up to 8 pairs (Data and Control Input)
Input Block Size:	any
Number of Outputs:	up to 8
Output Block Size:	depends on module setting
Max. Number of Modules:	any

This module will save a data point into a block each time it receives a rising edge at the Control Input. The block (register) is initially filled with zeros which are replaced by real data. The module continually outputs the register as a block using the sampling rate/block size of the inputs. When the register is filled, the values shift to the left, losing the first sample, and adding the most recent to the end of the register.

This module is different from the Circular Buffer module, because it continuously outputs data, filling unused positions with zero. The Circular Buffer outputs a block on demand, without fill.

The module allows you to combine samples that are not synchronous or otherwise aligned in time.

Register Size: Define the register size in samples. That value defines also the output block size.

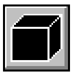
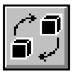
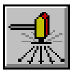
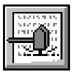
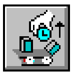
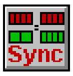
If the register is filled, the first (oldest) value is deleted and the new one is acquired (FIFO).

The block size at the module output is defined by the register size. The relation of sampling rate and block size is the same as at the input:
Global Sampling Rate =200 Hz; Block Size = 100; Register Size = 10
➔ At input A/B = 200/100 = 2 ; at output Register Size = B = 10 => A = 20

Chapter 12
Special Modules

Chapter 12: Special Modules Group

This module group consists of modules for creating Black Boxes, Event Driven Actions, and for manipulating the time base of the signal.

	Module	**Basic version**	**optional**
	**New Black Box**	x	
	**Export / Import Module (Black Box)**	x	
	**Action**	x	
	**Message**	x	
	**Time Base**	x	
	**Signal Adaptation**	x	
	**E-MAIL**	x	

1. Black Box

Concept and Handling

With ***ServiceLab***'s Black Box concept you can create worksheet elements often used in your experiments, integrate them into one module (the Black Box) and use them in future worksheets as ready-to-use units.

Use Black Box modules to create your own modules which perform custom algorithms to meet your specific needs.

This modular approach simplifies experiment setups by reducing the number of elements (modules and data channels) in the worksheet. It also saves time, as subordinate standard tasks need not be set up each time.

The Black Box module contains a complete worksheet, with modules arranged on a worksheet and connected with each other through data channels. The worksheet is just another ***ServiceLab*** worksheet. This means, for example, that it may use up to 256 modules.

On the worksheet, the Black Box module looks like any other module. It can be installed and handled in a similar way, it may be configured with several inputs and outputs, and it can be connected to the other modules.

The Black Box module itself has an “inside” and an “outside”:

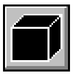
- Inside, it contains a complete worksheet, with modules arranged on a work area and connected to each other through data channels. The complexity of that worksheet is the same as that of any other ***ServiceLab*** worksheet. This means, for example, that it may contain up to 256 modules.
- Outside, the Black Box module looks like any other module on the worksheet of which it is an element. It can be installed and handled in a similar way, it may be configured with several inputs and outputs, and it can be connected to the other modules as usual.

Black Box modules offer some additional features:

- On a Black Box worksheet you can insert another Black Box module, which can then contain a Black Box module again, and so forth. Thus, the worksheet becomes three-dimensional in a way, with the Main Chart (on the actual ***ServiceLab*** work area) and several layers of subordinate Black Box levels, each one embedded into the preceding one.
- You can freely move up and down between levels using menu commands and a Function Bar icon.
- Data is exchanged between a worksheet and a Black Box worksheet embedded into it using the Export and Import module. This module may be provided with up to 16 inputs and outputs.
- Each Black Box module can be saved separately, so that you can easily edit, manage, and insert several of them independently.

- Each Black Box can be protected with separate passwords, so that it cannot be opened or changed.

1.1. New Black Box



Use this command to insert a Black Box module into the worksheet.

1.1.1 Black Box Module

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	up to 16
Output Block Size:	any
Max. Number of Modules:	any

The Black Box module symbol appears on the ***ServiceLab*** work area like any other module, but is initially empty and does not have input or output symbols.

Double-click the Black Box module symbol to open the Black Box module worksheet. The Black Box module displays an empty worksheet. The worksheet looks like that of the main chart except the background color is different to indicate the new level (see below).

Black Box Worksheet

You can create the Black Box worksheet by installing modules, configuring and connecting them, just as on the main worksheet.

Like any other ***ServiceLab*** worksheet, a Black Box worksheet may contain **up to 256 modules**.

Each Black Box can have its own Module Bar. You can create multiple customized Module Bars adapted for each Black Box task, save them to files and open them later. Choose the commands from the Module Bar submenu on the Edit menu to do so.

These settings will be saved with the Black Box worksheet.

Black Box Configuration

A Black Box can have up to 16 inputs and up to 16 outputs. These cannot be selected using a Channel Selection Bar, as with other modules, but they are created when Black Box Export/Import modules are installed on the Black Box worksheet.

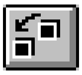
The number of inputs is independent of the number of outputs; the input block sizes and input rates are independent of the output block sizes and output rates.

Use the Black Box Info command from the Edit menu to specify a Module Name for the Black Box. You can also enter a descriptive text string and a Short Cut identifying tag for the Black Box module symbol on the Module Bar.

Black Box Levels

In a Black Box worksheet, you can insert another Black Box module, which can then contain a Black Box module again, and so forth, down to any level.

Leaving a Black Box



You can enter or open a Black Box by clicking its module symbol on the worksheet; you can leave or close it to return to the preceding worksheet level by clicking this Function Bar icon, or by choosing the command from the Black Box Module submenu on the Edit menu (see Chapter 4 of the UserGuide for more information).

A Black Box may be closed either by clicking this function bar icon, or by choosing the command from the Black Box Module submenu on the Edit menu.

This command has **two names:** It is either Back to the Main Chart (if the current Black Box is an element of the Main Chart), or it is To Preceding Black Box Level (if the current Black Box is itself an element of another Black Box worksheet).

After a Black Box has been closed, the worksheet on the preceding level is activated.

You can ***enter*** *a Black Box (i.e. activate its worksheet for editing)* ***only*** *by double-clicking its module symbol on the worksheet*

Data Transfer between Black Box Levels

Data is transferred between the main chart and the subordinate Black Box worksheet using the Export/Import module. This module can be selected from the Black Box module group on the Module menu or from the Module Bar.

You can ***switch*** *between black boxes and the worksheet while measurement is running.*

Colors

The default background color setting of a new Black Box worksheet is blue. The color settings can be selected individually for each Black Box. Choose the Colors command from the Options menu to do so.

These settings are saved with the Black Box worksheet.

Use the background color as an indicator of the Black Box level. For example, a color code could be: the lower the level, the darker the color.

Black Box Files

Each Black Box module can be saved separately and can be edited, managed, and installed independently.

The first 20 Black Box files in the ***ServiceLab*** directory will appear as menu items on the Black Box Module submenu of the Module menu. Their Module Names (as entered in the Black Box Info dialog box) appear as menu commands.

The Short Cut tag (as entered in the Black Box Info dialog box) is a string of up to 3 characters which is used to identify the Black Box module on the Module Bar. The Module Bar icon representing that Black Box displays that tag.

For further information on the Edit menu commands to create, save, open and edit Black Boxes, please refer to Chapter 4 of the User Guide.

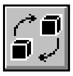
Black Box Properties

In this dialog box you can enter descriptive text and identifying tags for the Black Box module.

- The Module Name helps to identify the module symbol in the worksheet.
- The Black Box module symbol in the main chart (or the preceding worksheet level) displays this name in its title bar**.**
- The first 20 Black Box files in the ***ServiceLab*** directory automatically appear as menu items on the Black Box Module submenu of the Module menu. Their Module Names appear as menu commands.
- In the Description box you can enter a short comment on the functions implemented in the Black Box.
- The ID Tag is a string of up to 3 characters. It is used to identify the Black Box module in the module bar. The module bar icon representing that Black Box displays that tag.

  A Black Box can only be saved if an ID Tag has been entered. If the identifying tag is missing, the Black Box Info dialog box will appear when you save the Black Box.
- The Password Protection check box enables separate password protection for the actual Black Box worksheet. If the password is not defined, activating the option will open the input box for the password. The Change... button opens the input box if a password already exists.

1.2. Export / Import Module



This module provides the connection between a Black Box worksheet and the main chart (or the preceding worksheet) of which that Black Box is an element. It transfers data between these two worksheet levels.

Each Black Box worksheet can contain only **one** Import module and **one** Export module.

To establish the connection, the module must be present on both worksheet levels. The Export or Import module symbol in the Black Box worksheet and the module symbol of that Black Box in the main chart provides the corresponding number of output and input symbols.

This module can only be inserted into a Black Box worksheet. The Export/Import module can be included on the Module Bar.

When the module is inserted into the Black Box worksheet for the first time, select one of the following module types:

- Export Data
- Import Data

Once the module is integrated into the worksheet, its module configuration dialog box provides the settings and options specific to the selected type. To change the type, delete the module first, and install it again, choosing the new type.

Up to 16 module entries or outputs can be activated.

Unlike most other modules, the number of inputs is independent of the number of outputs; the input block sizes and input rates are independent of the output block sizes and output rates.

1.2.1 Export Module

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	1 per Black Box

Use this module to transfer data from the Black Box worksheet to the main chart (or to the worksheet on the preceding level) for processing.

- The Export module provides only inputs for the data going out to the main chart.
- The Black Box module provides the corresponding number of outputs to deliver data from the Black Box worksheet to the main chart.

Each Black Box worksheet can contain only one Export module.

1.2.2 Import Module

Input and Output Characteristics

Number of Inputs: ---
Input Block Size: ---
Number of Outputs: up to 16
Output Block Size: any
Max. Number of Modules: 1 per Black Box

Use this module to receive data from the main chart (or the worksheet on the preceding level) to process it in the Black Box worksheet.

- The Import module provides only outputs for the data coming in from the main chart to the Black Box worksheet.
- The Black Box module provides the corresponding number of inputs to deliver data from the main chart to the Import module on the Black Box worksheet.

Each Black Box worksheet can contain only one Import module.

1.3. List of up to 20 Black Boxes

The first 20 Black Box files in the ***ServiceLab*** directory will appear as menu items on the Black Box Module submenu of the Module menu. Their Module Names as entered in the Black Box Info dialog box appear as menu commands.

Simply choose the menu command to install that Black Box in your worksheet.

⇨ ***ServiceLab*** *can only list a Black Box file on the menu if the Module Name has been entered for the Black Box before saving it.*

For information on how to save a Black Box, on the Black Box Info dialog box, and on related Edit menu commands, please refer to Chapter 4 of the User Guide.

Any of the Black Boxes can be installed on the Module Bar. Their Short Cut ID Tag (as entered in the Black Box Info dialog box) will be used to identify the Black Box on the Module Bar. The Module Bar icon representing the Black Box displays that tag.

You can insert any Black Box, saved in any directory, into your worksheet by choosing Open... from the Black Box Module submenu of the Edit menu.

2. Event Driven Actions

Concept

The concept of the Event Driven Actions represents a powerful set of tools for the automation of actions in ***ServiceLab***. Based on user determined conditions, a wide variety of module actions can be triggered, including printing display instruments, resetting internal values of the mathematics modules, logging of events, alarms, etc.

Sender / Receiver

An event driven action involves two (2) partners: a **sender** and a **receiver**.

A **sender** is an Action module that evaluates an incoming data channel with respect to various conditions. It **initiates** a desired action.

The **receiver** (specified in the Action module) is the module that performs the action or it is the main window in ***ServiceLab***.

The assignment of action and receiver is made in the Action module via the name of the receiver. The assignment to the action is lost if the name of a module performing an event driven function is changed after setting the action or if the receiver is deleted from the worksheet.

Synchronous / Asynchronous Actions

- Synchronous Actions: Synchronous actions are performed on the data block where the actions occurred. The data stream triggering the action must be synchronous to the data stream the action should influence.

  For example, it is not possible to apply a synchronous action that has been initiated by a relay triggered data stream to an untriggered data stream. Such tasks are only suited for asynchronous actions.

  Synchronous actions are reasonable in cases where actions must occur at an exact point in time in a data stream. A good example is the printout of a special data block.

  Synchronization is treated as an additional internal data channel and thus requires computing time even if no actions are initiated.

  The action always relates to the beginning of the block if the position within the data block is of importance to a synchronous event (for example, with a Reset action).

  The action is performed just once for the evaluated data block if the condition to initiate an action is satisfied within an evaluated data block more than one time.

  For synchronous actions, the data must arrive at the Action module and at the Receiver module with the same block start time. Otherwise, ***ServiceLab*** will generate an error message.
- Asynchronous actions

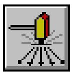
Asynchronous actions are performed without regard to whether the data initiating the action was already processed by the module which should perform the processing.

If, for example, the Print action is sent as an asynchronous action to the Y/t Chart module, it is possible that the corresponding data block is not printed but an earlier or later data block.

Asynchronous events feature a larger flexibility and are faster in the execution behavior. They should be used in such cases where the execution at the time of a certain data block is not required. A good example is the activation/deactivation of channels in a visualizing window.

Of special importance is the fact that processing of asynchronous actions does not require any additional computing time if no action is initiated (the Action module to evaluate the data is the exception).

2.1. Action Module



This module is used to initiate various actions in ServiceLab or in ServiceLab modules.

Once integrated into the worksheet, this module can initiate up to 16 different actions via one data channel.

Input and Output Characteristics

Number of Inputs:	1
Input Block Size:	any
Number of Outputs:	---
Output Block Size:	---
Max. Number of Modules:	any

The Action module can initiate up to 16 different Event Driven Actions. . You can define

- up to **16 actions** based on **one input** channel, or
- up to **16 input channels** with only **one action** for each channel.

Use the Channel Bar to specify the number of Event Driven Actions to be initiated.

The following specifications are required for each action to be initiated:

- one event condition,
- one receiver for the action,
- the action itself and
- the action dependent parameters.

Event

Specify the Event condition for which the input data block is evaluated. The following options are available.

Function	**the action is initiated**...
Rising edge:	when the input changes from TTL Low (numerical value 0) to TTL High (numerical value 5).
Falling edge:	when the input changes from TTL High (5) to TTL Low (0).
Threshold overflow:	when the input exceeds the specified threshold value.
Threshold underflow:	when the input is less than the specified threshold value.
TTL High level:	when the input is TTL High (5).
TTL Low level:	when the input is TTL Low (0).
Input larger than threshold:	as long as the input value is larger than the threshold value.
Input smaller than threshold:	as long as the input value is less than the threshold value.
Input value has changed	This event reacts to the changing of the values of the corresponding channel/module. The parameter used is the minimum percentage the value has to change to cause the action. The last value is taken as 100 %. Don't use the 0 %, because the program uses floating point values in the comparison, they are infrequently the same.
Input value is reached (±0.001%)	This event reacts to the correspondence of an input channel value with the defined target value. The parameter used is the target value. A difference of +/- 0.001 % between target and input value will be accepted, because the program uses floating point values in the comparison, they are infrequently the same.
Start/Stop of the measurement:	at the beginning and/or at the end of the measurement.
Global String has changed	if the named Global String has changed during measurement.
Global Variable has changed	if the named Global Variable has changed during measurement.
Always:	the action is constantly initiated.
Never:	the action is never initiated. (NOP)

The applicable threshold required for the condition is specified with Threshold. In the following events you can use global variables as parameter:

- Input larger/smaller than threshold
- Threshold over/underflow
- Input value has changed

⇨ *Use the Rising/Falling edge and Threshold over/underflow conditions as often as possible, since a hysteresis is applied to the condition.*

For example, a slowly rising signal will trigger an action with Threshold overflow only if the threshold is really exceeded. The next action will only be triggered after the signal has dropped below the lower threshold and then exceeds it again.

In contrast, for Input larger than threshold, an action is initiated for every block for which at least one value is larger than the set threshold. This means the action is initiated every time the threshold exceeds and for every following block until the signal value falls below the threshold value. Under certain circumstances this can initiate many undesired actions, requiring a significant amount of computing time.

Receiver

- Use Receiver to specify which module the initiated action should process.
- In the pull-down module list box all modules present in the worksheet (and which can perform actions) are listed together with the main window of ***ServiceLab***.
- Use Channel to specify which channels of the selected module should perform the actions. Individual channels can be separated with spaces or commas. Channel groups are entered with hyphens.

Example: To use the channels 1, 3, 7 and 9 up to 12 of the Receiver module for the event, enter: 1 3 7 9-12 or 1,3,7,9-12.

This setting does not influence actions relating to the entire module.

Action

Select the Action which should be initiated if the set condition is satisfied.

- In the pull-down list box, all Actions are listed which the selected Receiver module can perform.
- After selecting an Action, you can specify whether the action should be performed synchronously or asynchronously.

If the Receiver module can only asynchronously perform the selected action, this setting is selected automatically. The synchronous option is disabled.

Parameter

If the selected Action requires additional inputs these options can be set using the Parameter item.

This area of the dialog box depends on the selected Action. Depending on the selected Action, 1 text parameter, up to 4 integer parameters or up to 4 floating point parameters can be entered.

Above each input, a header explains the purpose of the Parameter. In all parameter settings, you can also use an "**internal" variable** of the Action module. This variable **`${INPUT}`** is only available in the Action module and contains the value of the input. For example, you can switch between several layouts controlled by the value at the input of the module.

Hint for using Global Variables in Actions

You can access Global Variables and Strings in different ways such as using numbers or corresponding names. To define them in Actions that use Variables or Strings as a parameter, please look at the following example:

The example is the **Set Variables area** action:

The variables settings are:

Name of Variable **2 = KLOPS**, numerical **Value = 5**,

Name of Variable **10 = MOPS,** numerical **Value = 8.**

The **value to be set** is **0:**

Parameter	***Result of action***
from 2 to 10:	Set Variables **2 to 10** to **value 0**,
from KLOPS to MOPS	Set Variables with the indices from variable KLOPS (Index = 2) and MOPS (Index = 10) to 0. The variables **from 2 to 8** are set to the **value 0**
From ${KLOPS} **To ${MOPS}**	Set the variables with the indices corresponding to the **contents** of variable KLOPS (= **2**) and the **contents** of variable MOPS (= **8**) to 0. The variables **from 5 to 8** are set to **value 0**.
Mixed use is allowed, e.g.	
from 1 ...to ${VAR_10}	Set the variables with Index **1** to the variable with the index corresponding to the contents of variable 10 (= **8**) to zero. So the variables **from 1 to 8** are set to **value 0**.

Notify

Each time an Action is performed, you can **Increment a Global Variable**. The variable is incremented at the end of the Action. Select a global variable from the list box.

Action List

This is an overview of the Event Driven Actions, of the modules which can perform such actions and of the applicable parameters.

Actions which change Displays

Action	Receiver	Description	Parameter
Select Window Arrangement	global function	Activates previously stored display window arrangement	Window Arrangement number
Activate Layout	global function	activates a Layout window	Layout Number
Update Layout	global function	updates a Layout window	Layout Number
Layout into window	global function	switches the Layout into window mode	___
Show Flowchart	global function	switches loaded Flowchart into foreground window	___
Layout Full screen	global function	switches the Layout Window to full screen	Layout Number
Actualize Layouts	all Visualization modules	updates the display windows in all Layout windows	__
One Chart	Y/t, X/Y, Chart Recorder	switches display mode to One Chart mode	---
Multiple Charts	Y/t, X/Y, Chart Recorder	switches display mode to Multiple Charts mode	---
Fade out Channel	Y/t, X/Y, Chart Recorder, List	deactivates the display of one or more channels	list of channels
Fade in Channel	Y/t, X/Y, Chart Recorder, List	activates the display of one or more channels	list of channels
Freeze / Actual	Y/t, Chart Recorder	freezes data in display window or switches to the actual data display	___
zoom area (shift left/right gr/sm ...)	Y/t, Chart Recorder	shifts zoom area to left, right, beginning or end	---
Restart Reference Curve	Y/t, Chart Recorder	Restarts the Reference curve used in the display module	Reference Curve File name
Display range to ...	Chart Recorder	Sets the chart recorder X-axis display range to the defined number	value in sec. min. or hours
Set Title	Y/t, X/Y, Chart Recorder	sets new title for the display window	any text

Actions which create Messages or alerts

Action	Receiver	Description	Parameter
Message	Message	displays a Message and/or logs it (printer/file)	any text
close/open file	Message	closes or opens the named file (also global strings are useful)	File name or global String
Message with Acknowledge-ment	Message	displays a Message and/or logs it (printer/file). This message must be acknowl-edged by the user before it is erased from the screen.	any text
Play Wave file	Message	plays a wave file	name of wave file
AVI File start	Message	starts the AVI file declared in the message module	No. of the AVI file
AVI File Pause	Message	pauses the replay of the AVI file	-
AVI File next Frame	Message	switch to the next frame of the AVI file	-
AVI file before Frame	Message	switch to the previous frame of the AVI file	-
Send eMail	Email	sends an text message via email to the defined address	--
Send message via DDE	Message	sends an text message via DDE to the defined DDE application	Any text or command string

Actions to set or modify Global Variables / Strings

Action	Receiver	Description	Parameter
Set String	global function	defines a global string	No. ,string (ASCII)
Save String	global function	saves a global string in ***SERVICELAB***.INI	No. ,string (ASCII)
Load String	global function	loads a global string from ***SERVICELAB***.INI	Number
Save string into file	global function	save a global String into the named INI file	No.,String (ASCII), Name of INI file (also String)
Read string from file	global function	reads a global String out from the named INI file	No., Name of INI file (also String)
Read String area	global function	reads a range of global strings	No. (from ...to)

Write String area	global function	writes a range of global strings	No. (from ...to), value
Read String area (file)	global function	reads a range of global strings out of the named INI file	No. (from ...to), Name of INI-file (also string)
Write String area (file)	global function	writes a range of global strings into the named INI file	No. (from ...to), Name of INI-file (also string), value
Set Variable	Module: Write Global Variable	Sets all global variables defined in the module	)
Set Variable	global function	defines a global variable	No., value (ASCII)
Set Variable	Latch	defines a global variable out from the received data	No. of Variable
Set Variable Area	global function	sets a range of global variables to the specified value	No. (from ...to), value
Save Variable	global function	saves a global variable in ***SERVICELAB***.INI	Number
read variable from file	global function	reads a global variable out of the named INI file	No., Name of INI-file (also string)
write variable to file	global function	saves a global variable into the named INI file	No., Name of INI-file (also string)
Read Variable area	global function	reads a range of global variables	No. (from ...to)
Write Variable area	global function	writes a range of global variables	No. (from ...to), value
Read Variable area (file)	global function	reads a range of global variables out of the named INI file	No. (from ...to), Name of INI-file (also string)
Write Variable area (file)	global function	writes a range of global variables into the named INI file	No. (from ...to), Name of INI-file (also string), value
Variable + value	global function	adds a numerical value to a global variable	No., value (ASCII)
Variable * value	global function	multiplies a global variable by a numerical value	No., value (ASCII)
Load Variable	global function	loads a global variable from ***SERVICELAB***.INI	___

Actions which affect the program or System

Action	Receiver	Description	Parameter

Stop program	global function	exit ***ServiceLab***	---
Exit Windows	global function(not in Windows NT)	exit **Windows**	---
Restart Window	global function(not in Windows NT)	exit and restarts Windows	---
Start external program	global function	starts the named program	Name of program incl. path + additional commands
Load Worksheet	global function	loads another worksheet after stopping the current one	file name of the worksheet
Load and start worksheet	global function	loads and starts another worksheet	file name of the worksheet
Stop worksheet	global function	stops the current measurement	-
Stop / Restart worksheet	global function	stops the current measurement and starts it again	-
Create directory	global function	creates a new directory	Name and path of the new directory
Lock Screen	global function	Screen Locking on	___
Unlock Screen	global function	Screen Locking off	___

Actions to Save or Read data

Action	Receiver	Description	Parameter
Backup	Write Data	Backs up Data on Hard disk	path
Next file	Write Data	Switches to next multi file in file sequence	__
Next file	Read Data	Switches to next multi file in file sequence	__
open/close	Write Data	Data file will be opened and checked (or created new, if a global String is used)	file name (or global String)
Reset	Read Data	Reading of data starts at the beginning of file, (or a new file is opened, if a global String is used)	file name (or global String)

Actions that control data flow

Action	Receiver	Description	Parameter
Open Relay	Relay	causes the Relay module to pass data	___

Close Relay	Relay	causes the Relay module to stop data	___

Actions to Print or Copy to Clipboard

Action	Receiver	Description	Parameter
Print Layout	global function	prints a Layout	Number of Layouts
Print Display Window Contents	Y/t, X/Y, Chart Recorder, List	prints contents of display window	---
To Clipboard	Y/t, X/Y, Chart Recorder, List	copies contents of display window to clipboard	---

Actions which change the module function type or parameters

Action	Receiver	Description	Parameter
Set Value	Slider	sets the regulating value to a specific size	
Set Value	Generator	sets, adds or multiplies frequency, amplitude or offset values	---
Load Bitmap	Status Lamp	loads a Bitmap as symbol in status display	Name of Bitmap-File
Change Type of Filter	FFT Filter	changes type of Filter	identification digit
Change Type of Control	Two-Point Control	changes type of Control	identification digit
Change operating mode	PID Control	changes type of operating mode	identification digit
Change Type of Control	PID Control	changes type of control	identification digit
Reset Control	PID Control	resets the parameters of PID control	identification digit
Toggle switch	Switch	toggles to the other switch position	---
Close/open	Scaling	Reference file will be closed and a new will be opened	file name (or global String)
Zero point	Scaling	Calculates the Zero Point Offset Adjustment for the scaling module	---
Reset zero point	Scaling	Resets the Zero Point Offset Adjustment for the scaling module	---
Reset	*)	resets the internal value	---

*) with the PID Control, Time Base Arithmetic, Integral, Average, Statistical Values, Counter, Timer, Time Slice modules

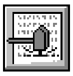
Actions which control the I/O interface modules

Action	Receiver	Description	Parameter
Send Data Request	RS232/IEEE-Interface	sends the defined data request commands to the external device	___
Send Start Commands	RS232/IEEE-Interface	sends the defined start commands to the external device	___
Send String	RS232/IEEE-Interface	sends the defined string to the external device	___

Please refer to the notes in the README file since the features of this module are under constant development.

For some actions you can specify whether the action should be performed synchronously or asynchronously.

2.2. Message Module



This module is used to display and output messages initiated by one or several Action modules.

The module does not have any inputs or outputs.

Input and Output Characteristics

Number of Inputs: ---
Input Block Size: ---
Number of Outputs: ---
Output Block Size: ---
Max. Number of Modules: any

With the Message module you can receive text messages from Action modules and output those on a **Screen,** a **Printer** or write the information into a **Log file**.

Use Options to activate or deactivate additional global functions.

- Manual input for messages opens a text input window. Using this window, text messages can be generated without influencing the measurement execution speed.

  The text can be typed in at the Message to be entered field. After clicking on the Send switch, the message is sent to the owner module and the message is deleted from the input field.
- In the Action module, you can choose between normal text messages and text messages which must be acknowledged in a message window. With

messages which must be acknowledged, a setting window is displayed for acknowledging the message. Message and acknowledgment are logged in the log file and on the log printer.

If Deactivate acknowledgment is selected, messages which must be confirmed are not required to be acknowledged any more. Messages are not logged in the log file if the message to be acknowledged is not confirmed until the occurrence of the next message.

- Use Message output device to determine to which output device the message will be sent. Any combination of output devices is possible.

  Click Options to specify settings for the output devices: Message window, Log printer, Log file, DDE Poke/Execute WAV file and AVI File.

2.2.1 Message Window Options

These options influence the appearance and the format of the text to be displayed by the Message module in the message window.

- Use Window options to determine the behavior of the message window when new messages are coming in.

  Windows (starting with version 3.1) differentiates between 2 priorities for the display of windows: normal windows (which can overlap and cover each other) and always visible windows (e.g., Windows Clock or Help windows, if the Always On Top setting is activated).
- Window always on top: in any case the message window is always displayed on top of all other windows (also on top of dialog boxes, menus, etc.). Visibility is thus guaranteed.
- Open window at message: the message window is displayed on top if a new message arrives. A minimized message window (icon) will be enlarged.
- Use History options to specify the representation of the window.
- Display only last message: a new message will always overwrite an existing message. Thus, only the newest message is visible.
- Message with history: all incoming messages are stored. You can scroll within the already received messages.
- Empty at message start: at a stop or restart of the message the internal buffer of the message window is emptied. In the course of a measurement the buffer contents is preserved.
- Use Additional information to select further information which will be shown with the actual message.
- Date and time: the time the message came in will be displayed with the message.

- Time representation: the time the message came in can be output in real-time (current date, current time) or as past time since the start of the measurement.
- Message number: the current number of the recent message is also logged.
- Send module: the name of the module sending the message is also output.
- Use Text formatting to select whether additional information in a separate line and whether an empty line should be inserted between the messages.
- Use the Font switch to select the font, the font type, the font size and the color. Use the Color switch to set the color of the background. By default, the messages are black on a white background.

2.2.2 Log Printer Options

These options influence the appearance and the format of the text to be output by the Message module on the log printer.

For this function ***ServiceLab*** does not use the Windows Print manager nor the default printer selected with the Windows Control panel. The selected log printer is accessed **directly** and **immediately** for outputting a log message. The program also does not wait until a page is full.

⇨ A simple matrix printer or ink jet printer, if applicable, with continuous paper is probably best suited for this application. Please note that this printer **must not** be used for other applications at the same time.

- Use Printer options to specify the basic settings for the connected log printer.

  The communication port the log printer is connected to is selected with Interface.

  With the settings Lines per page, Lines at top of page and Lines at bottom of sheet, you can specify the Page format of the log printer. Please refer to your printer manual for the relevant information.

  ServiceLab always prints a message completely on one page. If the lines of a message do not fit in the remaining space of a page, then the entire text will be printed on a new page.

Select 72 lines per page for DIN-A4 size page. Select 66 lines per page for the U.S. 8.5 x 11 format.

- With Additional information you can select further information which will be outputted together with the actual message.

  Date and time: the time the message came in will be outputted together with the message.

Time representation: the time the message came in can be outputted in real-time (current date, current time) or as past time since the start of the measurement.

Message number: the current number of the recent message is also logged.

Send module: the name of the module sending the message is also outputted.

- With Text formatting you select whether additional information in a separate line and whether an empty line should be inserted between the messages.

Log File Options

These options influence the appearance and the format of the text to be output by the Message module into the log file.

- Use File to specify the name of the log file to be written.
- Use file options to specify the behavior of ***ServiceLab*** at the start of a measurement. If Stop if file exists is selected, the measurement will not be started at all if the selected file exists and a warning message is displayed.
- Use Additional information to select additional information which will be output with the actual message.

  Date and time: the time the message came in will be output together with the message.

  Time representation: the time the message came in can be output in real-time (current date, current time) or as past time since the start of the measurement.

  Message number: the current number of the recent message is also logged.

  Send module: the name of the module sending the message is also output.
- Use Text formatting to select whether the additional information in a separate line and whether an empty line will be inserted between the messages.

Send String via DDE Poke/Execute Options

The Send string via DDE Poke/execute option allows you to send text messages from the Message module via DDE to other applications. The strings can contain simple text such as command strings to be sent to a running application. The allocation of the strings to the events is controlled by an Action module.

- DDE Receiver

  Name the Application and the target area where you want to send the string. You must insert the program name in the "Service" field and the

target area in the "Topic" field. Please also see the program description of the target Application to determine the correct settings.

You can use two different send modes (Type of connection):

DDE Poke: The message is sent to the defined Name (Item) of the selected connection.

DDE Execute: The "receiver" application is instructed to process a defined command (in this case the Topic is often SYSTEM). The Item entry is not available for this setting.

- DDE Communication

  This setting defines when the connection to the receiver is built.

  Connection: Either the DDE connection can be established at the Start of measurement and held open or it can be re-established for each new message, where the message is sent and the connection is ended. The second option needs considerably more time for each message, but it provides a reliable method to verify each time a message is sent (if a Net DDE connection is used), that a stable connection can be sustained.

  What happens on communication errors: If there are errors in communications (e.g. break of the Net DDE connection because the target PC is turned off) three options are available:

  (a) The measurement is stopped and an error message is displayed.

  (b) The communication link is ended and open again, to be prepared to send the next message.

  (c) Any error will be ignored (if the Open DDE link at Start option is used, the connection will crash).

- Logging Communication Errors:

  You can specify that the errors can be logged. Any error messages are send to the open message window, the log printer or/and the log file of the same message module. To use this option you must activate the relevant options in the Message Module. The format settings have to be made in the corresponding option dialog boxes.

Wave File Options

You can define the wave files which will be played by the Message Module using an installed sound board.

- In the Selected WAVE Files window, the wave files can be defined by number using the File Name button. Up to 20 files are accessible. Link the wave with specified actions in the Action module.
- To define the way ***ServiceLab*** replays the wave files in the Option box:
  - Play default if wave file isn't accessible.
  - Stop sound at end of experiment.

- Play wave file once; don't start new sound while playing.
- Play wave file once; start new wave file immediately on action.
- Repeat wave file until new wave file is selected by action.

AVI File Options

You can define the AVI files which should be played by the Message Module.

- All AVI files are displayed in the Selected AVI files window, and are defined by number using the File Name button. Up to 20 files are usable. Links of the AVI with specified actions are made using the Action Module.
- You define the way ***ServiceLab*** replays the AVI files in the Option box
  - Scale AVI window: If this switch is **not used**, the AVI file is displayed in **1:1 format**. If it is **activated**, the AVI picture is stretched to the border defined in the layout. The following additional setting is available:
  - Proportional Scaling: The AVI picture is stretched to the border, but the original aspect ratio is used.

2.3. EMail Module

Use this module to send an e-mail message controlled.

Input and Output Characteristics

Number of Inputs:
Input Block Size:
Number of Outputs:
Output Block Size:
Max. Number of Modules: any

The module creates an email message to the defined email recipient and sends it triggered by an Event Driven Action. We have tried to test with a wide variety of mail packages.

You can define:

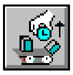
- Email address (To:):
- Copy recipient (shown/hidden CC/BCC)
- Subject
- Message
- Attachment.

The Setup button opens the windows dialog box to create an email profile.

3. Manipulating the Time Base

The Time Base and Signal Adaptation modules are provided to allow you to manipulate the time and block information of a channel. There are applications where you may need to extract the time information from a channel, or you may need to change the time and block information of a channel to match another channel.

3.1. Time Base Module



This Module either extracts time information from a data channel or from the global acquisition rate and then sends it to the output as data.

Function types

Since this module provides different basic operations, you must first select the function type when you install the module.

- The Extract Time Base From Data Channel function type provides a module with inputs. Time information is extracted from the data stream of up to 16 data channels and, for every data value, it is applied as time value to the corresponding output.
- The Generate Global Time Base function type provides a module without inputs. The time information is derived from the global acquisition rate.

Settings

Format sets the type of the output data per channel.

- Measurement Time Since Measurement Start specifies the number of days which have elapsed since the start of the measurement as related to the current channel.
- Measurement Time Since Measurement Start specifies the number of seconds which have elapsed since the start of the experiment as related to the current channel.
- X-base in seconds, Hertz or pieces outputs...
  - … for the first function type, the additional information of the time, of the frequency or the number of the values for this channel. If, for example, frequency data of a FFT module is involved, the frequency of a value will be made available at the output.
  - … for the second function type, the global time information in seconds.
- Block Size at Input gives Block Size.
- Sample Rate at Input in Hertz gives Sample Rate in Hertz (1/sec.).
- Sample Distance at Input in Seconds gives distance in seconds between single samples.

- Sample Distance at Input in Seconds gives distance in seconds between single samples.
- Real Time Status (only with function type 2)**:**

  Each data generating module creates a data record if the internal time is larger than the time according to the last sample of a data block. So if the worksheet isn't able to run under real time conditions, the data block is transmitted after a delay time. This function calculates these delay times.
- Time of Day calculates the number of seconds elapsed since midnight. In contrast to th other functions the calculated value depends not on the measurement time but on the system time of the PC.
- <new, De 28.05.1998>Pulse each Second, ... Minute, ... Hour, ... at Midnight generates TTL-pulses at the defined time. Only one pulse (one TTL-High sample) is generated in the output block. This function depends on the PC clock. For example it can be used to control via event driven action the switching to next file in multifile saving.

In addition the output values can be reset after a specified number of blocks.

⇨ *This option is only available with X Base setting. If an event-driven action is used to initiate the reset, the action will be ignored when one of the other options is chosen.*

This module opens up various possibilities for further evaluation and control of sequences.

Time Base Extracted From Data Channel

This function type of the Time Base module extracts time information from up to 16 data channels and applies it to the output.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as input
Output Block Size:	same as input
Max. Number of Modules:	any

3.1.1 Generate Global Time Base

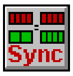
This function type of the Time Base module extracts time information from the global acquisition rate and applies it to the output.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	same as global block size

Max. Number of Modules: any

3.2. Signal Adaptation Module



This module synchronizes data streams that have different sampling rates, block sizes or starting times.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	input block size of the first channel
Max. Number of Modules:	any

This module changes parameters like the block size, the sampling rate or the start time of a signal representation. The first channel (channel 0) is used as a reference. Its parameters are copied to all the other channels (channels 1 to 15).

This module does not perform any calculation of the signal, but it changes its internal representation.

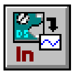
- Adapt Time Only: ***ServiceLab*** provides its data blocks with a time stamp representing the start time of this block. Calculations like addition or multiplication can only be performed on blocks with equal parameters like the sampling rate, the start time and the block size.

  This mode **synchronizes** the **start time** only. It is useful if the other parameters are equal and interpolation calculations are to be avoided.
- Full Interpolation: Many modules cannot process data blocks acquired at different sampling rates or block sizes if they have not been synchronized.

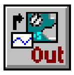
  The Full Interpolation option synchronizes differing data streams by interpolation; by modifying their block sizes or their sampling rates as much as necessary for further processing. The **first channel** (channel 0) is used as a **reference**.
- Ignore Real Time: With this setting, time info is built with Block Size * Sampling Rate, also while triggered data are received at input channel. This function is useful to link triggered data of DAP boards or of triggered channels.
- Off: No changes are performed at all. Output data will have the same representation as input data.

Chapter 13
Network

Chapter 13: Network Module Group



DataSocket Input



DataSocket Output

1. Network Modules

This group consists of modules which allow you to transfer data between several.

The network functions are based on the **TCP/IP** protocol which is not included in standard Windows or Windows for Workgroups installations. You will need to install the TCP/IP Stack to use the ***ServiceLab*** Network functions.

2. DataSocket Communication

2.1. Overview

DataSocket, both a technology and a group of tools, facilitates the exchange of data and information between an application and a number of different data sources and targets. These sources and targets include files, HTTP/FTP servers, OLE for Process Control (OPC) servers, and National Instruments DataSocket servers for publishing live data between applications. Often, these sources and targets are located on a different computer. You can specify DataSocket sources and targets (connections) using URLs (uniform resource locators) that adhere to the familiar URL model.

DataSocket uses an enhanced data format for exchanging measurement data, as well as the attributes of the data. Data attributes might include information such as an acquisition rate, test operator name, time stamp, quality of data, and so on.

Although you can use general purpose file I/O functions, TCP/IP functions, and FTP/HTTP requests to transfer data between different applications, applications and files, and different computers, you must write a significant amount of program code to do so. DataSocket greatly simplifies this task by providing a unified API for these low-level communication protocols. Transferring data across computers with DataSocket is as simple as using a browser to read Web pages on the Internet.

If DataSocket support is selected during the ***ServiceLab*** installation, the DataSocket library (cwds.ocx) and its required system files are installed in the Windows system directory and the DataSocket interface (DSocket.dll) is installed in the ***ServiceLab*** directory. By default, the DataSocket Server and Manager are installed in ...\Program Files\National Instruments\DataSocket, and creates a National Instruments DataSocket start menu subdirectory.

For further information see the separate Installation Guide and Help files of the DataSocket interface by National Instruments.

2.2. Other Information

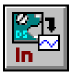
The tags in the OPC server that are used by the DataSocket Import module need to be configured in the OPC server before connecting to them or browsing to them from the DataSocket Import module.

If the OPC server is properly registered on the computer it will be started automatically when the flow chart is started. This may take a couple of seconds and you may want to start the OPC server manually to avoid this delay.

The DataSocket Import module does not process OPC data attributes including quality and time information.

The DataSocket Import and Export modules use the DataSocket technology from National Instruments to access the OPC servers. The DataSocket software (in addition to the ***ServiceLab*** DataSocket module) needs to be installed for these modules to work properly. This is normally done by the ***ServiceLab*** installation software if you select the DataSocket option during installation. You can also install DataSocket directly from the ***ServiceLab*** CD.

2.3. DataSocket Import Module



This module is used to connect to a data source using a number of different protocols and read data into the experiment. The Data-Socket Export module is used to write data to the different data targets.

This module can read data of up to 16 different data sources and transfer them to other modules using its signal channels.

For documentation purposes, the module can be provided with a description. The module name and the channel name are set automatically by ***ServiceLab***. The user can change these defaults.

Input and Output Characteristics

Number of Inputs:	---
Input Block Size:	---
Number of Outputs:	up to 16
Output Block Size:	1 or same as global block size
Max. Number of Modules:	32 Network modules (all types)

Operation

The DataSocket Import module is able to acquire data from up to 16 different data sources, including other applications using DataSocket (through the Data-Socket server), OPC servers, HTTP/FTP servers and more. The machine name and item name identifying the data source are configured for each signal channel individually. You can use multiple DataSocket Import modules on one flowchart to access more data sources. The data sources (servers) can be located on the same computer as ***ServiceLab*** or on another computer. In a remote application

cation using OPC, the OPC server must be properly registered on the local computer using DCOM and the DCOM configuration utility.

The connection to the data source is made when the flowchart with the DataSocket Import module is started. The connection is closed when the flowchart is stopped. All blocks of data returned from the DataSocket Import module are provided with the block size and timing information that is necessary to process data in ***ServiceLab***.

Data Format

The DataSocket Import module can receive data as single values or blocks (one dimensional array) of numeric data or strings. Reading arrays of strings from the data source is not supported.

URL Format

A URL is used to specify the data source from which data is read. The URL has the following format.

protocol://machine_name/item_name

For example,

dstp://localhost/samplenum

The machine_name, and item_name are specified in the dialog window of the module. When using OPC and if the OPC server is located on the local machine, the machine name field should be left empty. In this case the double slash is also not used in the URL.

opc:/server_name/tag_name

The item_name field is used to identify the OPC server and tag name and group, and has a format such as `National Instruments.OPCDemo/MotorRPMSensor`.

The complete URL in this case would be

opc:/National Instruments.OPCDemo/MotorRPMSensor

Module Settings

Connection

- The Type, Machine Name, and Item Name fields are used to specify the data source from which data is read. The complete URL build from these values is shown in the *URL* field

  The URL can also be directly entered by selecting Use Custom URL and entering the **URL** in the field. Changes in the URL are mapped back to the component fields according to the URL format. You can use this option to add optional parameters to the end of the URL.

- You can browse a DataSocket server and select an item from the server by pressing Select Item. The selected item is copied to the URL field and parsed to the individual components fields.

Data Source

You need to specify in the DataSocket Import module what type of data will be supplied by the data source. The three possible types of data are individual (scalar) numeric values, blocks (one dimensional array) of numeric data, and individual strings.

- Single Point – the data source supplies one numeric data item. The DataSocket Import module may combine consecutive values into a data block.
- Block Data - the data source supplies a block of data. The data is passed to the ***ServiceLab*** experiment in the same block. You should specify the maximum or exact block size of the data.
- String – the data source supplies a simple string. The string can only be passed to a global string in ***ServiceLab***. You must specify the global string number.

Options

The Options button opens a dialog where you can specify more detailed information about the **timing behavior** of the imported data. Data is returned by the module to the experiment according to these settings.

Return data every

- Data Update: The data is passed directly to the ***ServiceLab*** experiment when it is received from the data source, individual data points are returned as block of size one.
- **N seconds**: the data is returned to ***ServiceLab*** experiment at the specified rate. The data source is polled for new data at this rate. This is useful if you want to reduce the amount of network traffic in an application where you do not require fast updates in your application.
- Global Data Block: This option is only allowed with single point data. With this option individual data points are collected into blocks of data matching the global timing settings in your experiment.

Custom Sample Rate

Normally blocks of data returned from the DataSocket Import module are assigned the sample rate set in Experiment Setup. You can specify a custom sample rate that will be assigned to the imported data blocks. This option is useful if you know the original sample rate of the incoming data.

Load and Save

The Load and Save buttons are used to store and retrieve the settings of the DataSocket Import module. The files are stored with the suffix ***.DMS**

2.4. DataSocket Export Module

This module is used to connect to a data target and write data to the items in the specified target. The DataSocket Import module is used to read data from a data source.

This module can write to 16 different OPC tags.

For documentation purposes, the module can be provided with a description. The module name and the channel name are set automatically by ***ServiceLab***. The user can change these defaults.

Input and Output Characteristics

Number of Inputs:	up to 16
Input Block Size:	any
Number of Outputs:	same as number of inputs
Output Block Size:	same as input block size
Max. Number of Modules:	32 Network modules (all types)

Operation

The DataSocket Export module is able to send data to 16 different data targets, including other applications using DataSocket (through the DataSocket server), and OPC servers. The machine name and item name identifying the data target are configured for each signal channel individually.. You can use multiple DataSocket Export modules on one flowchart to write to more data targets. The data target (servers) can be located on the same computer as ***ServiceLab*** or on another computer. In a remote application using OPC, the OPC server must be properly registered on the local computer using DCOM and the DCOM configuration utility. (Other Information)

The connection to the data target is made when the flowchart with the DataSocket Export module is started. The connection is closed when the flowchart is stopped.

Data Format

The DataSocket Export module can write data as numeric or Boolean data. Data blocks with only one value are written as scalar values, data blocks with more than one value are written as one-dimensional arrays.

URL Format

A URL is used to specify the data target to which data is written. The URL has the following format.

```
protocol://machine_name/item_name
```

For example,

```
dstp://localhost/samplenum
```

The Machine_Name, and Item_Name are specified in the dialog window of the module. When using OPC and if the OPC server is located on the local machine, the machine name field should be left empty. In this case the double slash is also not used in the URL.

```
opc:/server_name/tag_name
```

The item_name field is used to identify the OPC server and tag name and group, and has a format such as `National Instruments.OPCDemo/MotorRPMSensor`.

The complete URL in this case would be

```
opc:/National Instruments.OPCDemo/MotorRPMSensor
```

Module Settings

Connection

The Type, Machine Name, and Item Name fields are used to specify the data source from which data is read. The complete URL build from these values is shown in the *URL* field

The URL can also be directly entered by selecting Use Custom URL and entering the URL in the field. Changes in the URL are mapped back to the component fields according to the URL format. You can use this option to add optional parameters to the end of the URL.

You can browse a DataSocket server and select an item from the server by pressing Select Item. The selected item is copied to the URL field and parsed to the individual components fields.

The Type, Machine Name, and Item Name fields are used to specify the data target to which data is written. The complete URL build from these values is shown in the URL field

Data Type

Data is written to the data target in the specified format. If you select to write Boolean data from ***ServiceLab*** in a numeric format to the data target, each True value will have a value of **5** and each False value will have a value of **0**.

Alphabetical List of Modules

Alphabetic List of Modules

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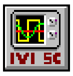	IVI Scope	Input/ Output	3-64

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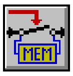
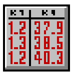
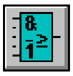
	Latch (optional)	Control	8-29
	List Display	Display	9-39
	Logical Operations	Mathematics	5-12

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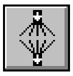
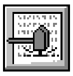
	Merge /Expand	Data Reduction	11-9
	Message	Special	12-18
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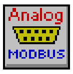
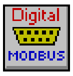
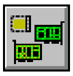
	MODBUS Analog In-put/Output	Input/Output	3-69
	MODBUS Digital In-put/Output	Input/Output	3-71
	Multi-Speed Analog Input	Input/Output	3-9

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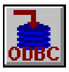
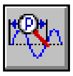
	ODBC Output	Files	10-23
	Period Check	Signal Analysis	7-22
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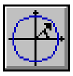
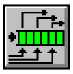
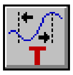
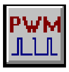
	Polar/ Cartesian	Signal Analysis	7-15
	Position in Signal	Statistics	6-5
	Pre/Post Trigger	Trigger	4-3
	Pulse Analysis	Statistics	8-12
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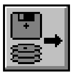
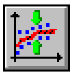
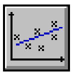
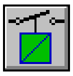
	Read Data	Files	10-2
	Reference Curve	Mathematics	5-24
	Regression	Statistics	6-8
	Relay	Trigger	4-7

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